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BULLETIN
OF THE
INTERNATIONAL RAILWAY CONGRESS
ASSOCIATION
(ENGLISH EDITION)

[621.155.4 & 625.215]

Memorandum on the running of railway vehicles on curves,

by F. LEGEIN,

Assistant Chief Mechanical Engineer, Belgian National Railways Company.

Although the running of railway vehicles on curves has been, for a long time, the subject of theoretical and experimental studies which have produced interesting results, it seems that the credit must be given to Herr UEBELACKER for having established, concerning the running of railway vehicles on curves, a theory sufficiently complete to allow of its practical application.

The aim of the present memorandum is to recapitulate the UEBELACKER theory as set out by him in 1903 in the *Organ für die Fortschritte des Eisenbahnwesens*, and develop it. The method of expounding it will be different; some details will be corrected and enlarged upon, the direct method of determining the centre of friction, given later by Herr HEUMANN for the case where the vehicle does not develop a tractive effort, will be generalised, and the movement of a vehicle out of its stable position will be dealt with.

Before going into the problem, we will set out the hypotheses which serve as the basis of the calculations :

(1) The wheels have the same diameter, and the tread of the tyres is cylindrical

(without conicity). They are fixed to the axles, and the boxes and bearings are assumed to be without play.

(2) The inertia forces are disregarded and the running is assumed to be at constant and low speed;

We shall see below that this hypothesis, made in order to simplify a first calculation, cannot be adopted. It will suffice to introduce into the calculation the forces of inertia that one wishes to take into consideration;

(3) The forces developed horizontally at the point of contact between the rail and tyre flange are reduced to a frictional force fQ developed on the tread (f being the coefficient of friction and Q the load on the wheel) and to a force exerted by the rail on the flange of the tyre at right angles to the centre line of the rail.

(4) The wheels will be assumed to be equally loaded.

It would be, moreover, easy to generalise by extending the calculation to the case where the loads are different.

* * *

Centre of friction.

Let us suppose that the wheels of a vehicle are without flanges and that they are running on a horizontal plane unlimited in extent, and without rails.

Under these conditions, the vehicle, not being under the influence of external forces, could move only on a straight line. Let us assume, however, that under the action of certain external forces the vehicle makes, at the considered moment, a rotation ω about an instantaneous centre of rotation O .

The instantaneous movement of the vehicle cannot then be made by simple running of the wheels; for this movement must necessarily be accompanied by an instantaneous sliding of the wheels on the plane.

This sliding produces frictional forces of intensity fQ on the tyres of the wheel, f being the coefficient of friction, and Q the load on the wheel.

These frictional forces have a constant value fQ , but their relative positions vary in accordance with the movement made.

Besides these forces fQ , other external forces applied to each wheel might be taken into account, such as a tractive effort, or braking force transmitted to the wheels through the underframe, a reaction between the rail and the wheel flange.

As these external forces can vary from one pair of wheels to another, we will consider the case of a single pair of wheels and afterwards generalise.

Let us consider, fig. 1, a pair of wheels AB effecting a rotation ω about the instantaneous centre of rotation O .

This rotation ω can be transferred to any point O' by introducing a couple of rotations $\omega \cdot a$ which is equivalent to a translation situated on the horizontal plane and perpendicular to OO' .

The only movement which the axle AB can make by simple running is a translation following the centre line of the vehicle; all other movements entail a slipping of the wheels on the plane.

In choosing the point O' on the perpendicular OH to the centre line of the vehicle, the translation $\omega \cdot a$ is shown, which does not entail slipping, and also the rotation ω about the point O' , a complementary movement, which involves the slipping of the wheels.

The point O' constitutes, therefore, an instantaneous centre of friction. The frictional forces acting on the wheels are obviously perpendicular to the radii $O'A$, $O'B$, (fig. 1). The choice of the point O'

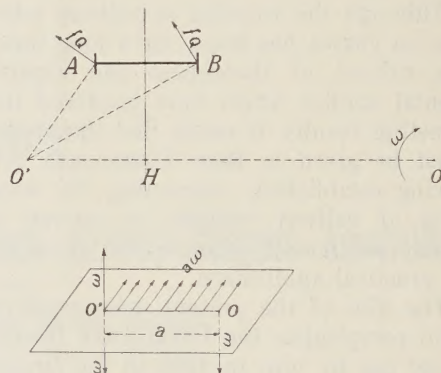


Fig. 1.

on the perpendicular OH being arbitrary, there is, therefore, for one and the same instantaneous centre of rotation O , an unlimited number of possible instantaneous centres of friction; but they are all located on the perpendicular OH .

The true position of the point O' on this perpendicular must, therefore, be determined by a condition of the problem.

Inversely, it can be said that if O' is actually an instantaneous centre of friction, the instantaneous centre of rotation O of the pair of wheels is found on the

it tends, by the progression of the vehicle round the curve, to decrease indefinitely.

The angle θ determined by equation (1) consequently corresponds to a stable position.

It should be noted that the tractive effort T is limited to $2fQ$ and that, in this case, O' is moved to infinity towards the left.

The right-angled reaction N is then nil.

The case of two pairs of wheels. — Let us consider two pairs of wheels *I* and *II* under the same underframe (fig. 3) and developing the tractive efforts T_1 and T_2 respectively.

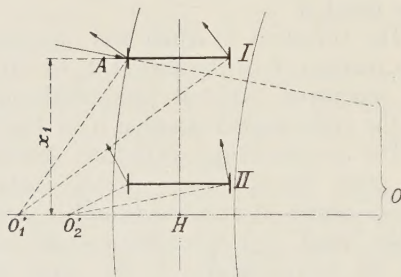


Fig. 3.

The reasoning will be analogous, but a new condition arises : *the centres of friction O'_1 , O'_2 of these pairs of wheels must be on the same perpendicular to the centre line of the vehicle.*

It is on this perpendicular that the instantaneous centre of rotation O of the vehicle is found, which obviously must be unique.

Reasoning as before it will be found that on each perpendicular there are two points, O'_1 , O'_2 , giving, for the corresponding pairs of wheels *I* and *II*, components of the forces fQ , the resultant of which balances the tractive efforts T_1 and T_2 .

The perpendicular which will give the true centres of friction will be that which produces equilibrium about the point A .

It would be easy to generalise for any number of pairs of wheels.

In principle, there will be as many centres of friction as there are pairs of wheels.

In the case of a locomotive having all the wheels coupled, the hypothesis advanced by UEBELACKER can be adopted, which admits that the points O'_1 , O'_2 , etc. coincide at a single point, the centre of friction common to all the wheels.

In view of what has been set out previously, this hypothesis amounts to admitting that the tractive effort developed by the locomotive is divided among the wheels in accordance with a law based on the fact that it has been admitted that the centre of friction was the same for all the wheels.

This simplified hypothesis is generally admissible for a locomotive, because the driving wheels, which take the main part of the tractive effort, are often arranged towards the back in the neighbourhood of the alignment $O'H$.

If, on the contrary, it is a case, for example, of a braked vehicle the brakes of which act equally on all the wheels, this hypothesis is no longer true, and it is then advisable to consider distinct centres of friction for each pair of wheels.

The case of a vehicle having neither driving nor braked wheels, working on a curve so that only the flange of the outside leading wheel A makes contact with the rail.

In order that such a vehicle may work round the curve, which gives rise to frictional forces, it is necessary to apply a tractive force P .

Let us assume that this force P is applied at the centre line of the vehicle (fig. 4). On the other hand, the outer

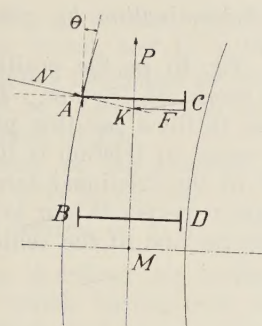


Fig. 4.

rail exerts on the wheel flange, at A, a reaction N at right angles to the curve.

This consideration provides the condition that the longitudinal components of the frictional forces fQ , for both wheels of a pair, namely $fQ \sin \gamma$ and $fQ \sin \gamma'$ (see fig. 5) must be equal in magnitude and act in opposite directions. This condition is necessary for the pair of wheels to be in equilibrium about its axis. Therefore the centre of friction M must be on the longitudinal centre line of the vehicle.

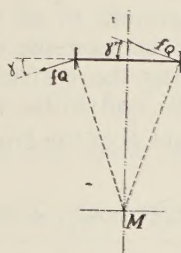


Fig. 5.

To state the problem more explicitly, the centre of friction, therefore, will be on the longitudinal centre line of the vehicle at a point where the resultant F of the frictional forces fQ (a resultant which is perpendicular to the longitudinal axis), balances the forces N and P .

In other words, the resultant of the

frictional forces F must pass through the point of intersection of N and P .

The centre of friction M being thus determined, at the same time as F , the corresponding resultant of the frictional forces, the values of the forces N and P can be readily deduced therefrom.

As a matter of fact, θ being the wheel contact angle at the outer rail, we have :

$$N = \frac{F}{\cos \theta}$$

and

$$P = N \sin \theta = F \tan \theta.$$

P is the force which must be applied at the centre line of the vehicle in order to move it round the curve. N is the reaction of the outer rail on the flange of the wheel A.

It should be noted that at the same point A, the rail sets up a frictional force fQ at the tread of the wheel. The total reaction of the rail on the wheel A is consequently obtained by the composition of the forces N and fQ (fig. 6).

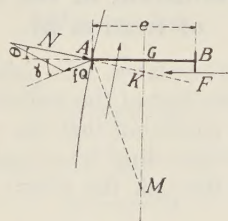


Fig. 6.

In the majority of the problems to be solved in practice the question is to determine the stable position of the vehicle in relation to the curve, as well as the corresponding reaction of the rail. *A priori* the value of the angle θ is unknown. Since this angle is generally very small, however (its value is not usually more than 2°), the problem is simplified by assuming that the resultant

of the frictional forces F passes, not through point K , but through the axis of the first pair of wheels AB .

If e is the distance between the rails, say 1.50 m. (4 ft. 11 in.), for example, it is seen that

$$GK = \frac{e}{2} \tan \theta$$

and for $\theta = 2^\circ$, it is found that

$$GK = 0.75 \times 0.03492 = 0.02619 \text{ m.}$$

a distance which, compared with the distances between the wheel centres, can be disregarded.

This is the approximation generally made, and it appears to be justified.

This approximation being admitted, it is seen that *the distance $x_1 = GM$ from the centre of friction M to the first pair of wheels no longer depends on the value of θ and that it is thus constant and independent of the radius of curvature of the outer rail.*

Determination of the centre of friction M .

As has been stated, this point is found on the centre line of the vehicle and must satisfy the condition that the resultant F of the corresponding frictional forces fQ must pass through the point A (fig. 7).

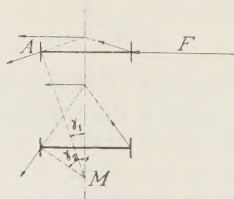


Fig. 7.

This point can be determined by calculation, by trial and error, or directly by a graphical method.

(a) Determination by calculation.

Let M (fig. 8) be the position of the required centre of friction. The condition to be fulfilled for this point to be the true centre of friction is that the resultant F of the frictional forces, which in this case is perpendicular to the longitudinal centre line of the vehicle, passes through A .

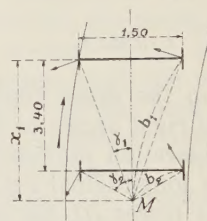


Fig. 8.

Let x_1 be the distance from the centre of friction to the first pair of wheels; b_1, b_2 , the distances from the point M to the contact points of the wheels;

γ_1, γ_2 , the angles shown in the figure;

fQ the magnitude of all the frictional forces set up between the rails and the wheels, f being the coefficient of friction and Q the load on the wheel.

The resultant F of the frictional forces is equal to

$$F = 2fQ (\cos \gamma_1 + \cos \gamma_2).$$

The moment of this force about the point M , which is also that of all the forces fQ about this point, is equal to

$$M = 2fQ (b_1 + b_2).$$

The condition to be fulfilled is consequently :

$$x_1 = \frac{2fQ (b_1 + b_2)}{2fQ (\cos \gamma_1 + \cos \gamma_2)} = \frac{b_1 + b_2}{\cos \gamma_1 + \cos \gamma_2}.$$

By varying x_1 a value satisfying this equation is found, and it is this value that determines the centre of friction.

It should be noted that the value of x_1 is independent of fQ .

In the case of the concrete example considered, it is found that :

$x_1 = 3.60 \text{ metres, or } 11 \text{ ft. } 9 \frac{23}{64} \text{ in.}$

It is easy to extend this method to the case of a vehicle having more than two pairs of wheels, but as the centre of friction may then be in front of the last pair of wheels, it is necessary to take into account the sign $\cos \gamma$.

Let us take, for example, the case of an 8-wheeled vehicle shown in figure 9.

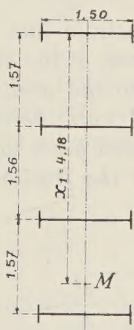


Fig. 9.

By applying the above method it is found that :

$x_1 = 4.18 \text{ m. (13 ft. } 8 \frac{5}{8} \text{ in.).}$

In order to make this calculation, the sum

$\cos \gamma_1 + \cos \gamma_2 + \dots$

is used, which enables the value of the resultant F of the frictional forces

$F = 2fQ (\cos \gamma_1 + \cos \gamma_2 + \dots)$

to be found at once.

The calculation is greatly facilitated by using a table giving for a particular track gauge, 1,500 m. (4 ft. 11 in.) for example, and for successive values of x , the corresponding values of b and $\cos \gamma$ (See *Bulletin of the International Railway Congress Association*, September 1929).

(b) Determination by graphical method.

Let us set out analytically the condition which the centre of friction must satisfy (fig. 10).

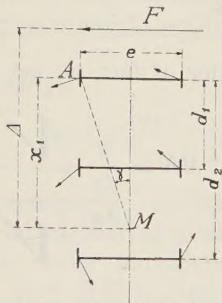


Fig. 10.

The moment of the frictional forces about M is

$$M = 2fQ \left[\sqrt{x^2 + \frac{e^2}{4}} + \sqrt{(x - d_1)^2 + \frac{e^2}{4}} + \sqrt{(x - d_2)^2 + \frac{e^2}{4}} \right]. \quad (2)$$

The resultant F is equal to

$$F = 2fQ \left[\frac{x}{\sqrt{x^2 + \frac{e^2}{4}}} + \frac{x - d_1}{\sqrt{(x - d_1)^2 + \frac{e^2}{4}}} + \frac{x - d_2}{\sqrt{(x - d_2)^2 + \frac{e^2}{4}}} \right]. \quad (3)$$

and the lever arm Δ about M is

$$\Delta = \frac{M}{F} = \frac{\sqrt{x^2 + \frac{e^2}{4}} + \sqrt{(x-d_1)^2 + \frac{e^2}{4}} + \sqrt{(x-d_2)^2 + \frac{e^2}{4}}}{\frac{x}{\sqrt{x^2 + \frac{e^2}{4}}} + \frac{x-d_1}{\sqrt{(x-d_1)^2 + \frac{e^2}{4}}} + \frac{x-d_2}{\sqrt{(x-d_2)^2 + \frac{e^2}{4}}}} \quad (4)$$

The point M will be the centre of friction when $\Delta = x$.

The graph, drawn by HEUMANN, is set out as follows (fig. 11).

On a horizontal axis XX' , let us show the position of the wheels.

Let us consider a point M at a distance x from the first pair of wheels A , and set off as an ordinate above the point M , the moment of the frictional forces about the point M

$$y = 2fQ \left[\sqrt{x^2 + \frac{e^2}{4}} + \sqrt{(x-d_1)^2 + \frac{e^2}{4}} + \dots \right] \quad (5)$$

By proceeding in the same way for a series of values for x , a continuous curve is obtained, a moment curve, which attains a minimum towards the middle of the vehicle and which extends to infinity at each side.

Let us demonstrate that the *tangent to the moment curve, at the abscissa point x corresponding to the position considered for the point M , cuts the axis of the x -es at a point K which gives the alignment of the resultant of the frictional forces.*

As a matter of fact, we get

$$MK = \frac{y}{\frac{dy}{dx}} = \frac{\sqrt{x^2 + \frac{e^2}{4}} + \sqrt{(x-d_1)^2 + \frac{e^2}{4}} + \dots}{\frac{x}{\sqrt{x^2 + \frac{e^2}{4}}} + \frac{x-d_1}{\sqrt{(x-d_1)^2 + \frac{e^2}{4}}} + \dots} \quad (6)$$

which is well the same as equation (4).

If the resultant of the frictional forces must pass through A , the method of determining the centre of friction proceeds directly from the foregoing.

A tangent is drawn through A to the moment curve, and the abscissa of the contact point gives the required centre of friction M_A .

As the scale adopted for the y -es does not interfere with the determination of the alignment of the force F , this scale

can be chosen at will, but it is advantageous to adopt a unit which is a multiple of

$$2fQ \times \text{unit of length.}$$

On the other hand, formula (3) can be written

$$F = 2fQ \cdot \frac{dy}{dx} = 2fQ \cdot \tan \alpha. \quad (7)$$

It follows, therefore, that the resultant F of the frictional forces is measured by the value of the angle α .

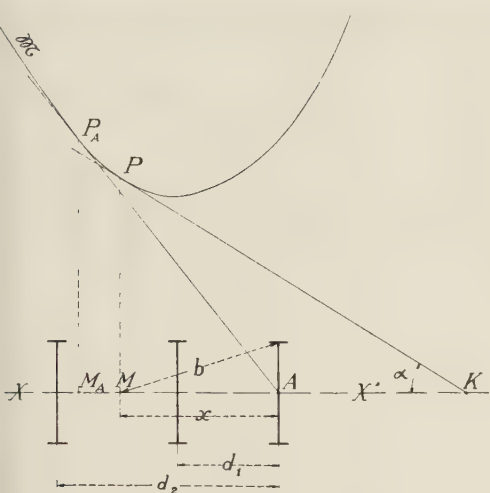


Fig. 11.

It is also seen that the moment of the resultant F of the frictional forces in relation to an axis ZZ' situated at a distance δ from its alignment is equal to

$$\begin{aligned} M &= F \cdot \delta \\ &= 2fQ \tan \alpha \cdot \delta \\ &= 2fQ \cdot z \end{aligned} \quad (8)$$

z being the ordinate of the tangent PK for the alignment ZZ' (fig. 12).

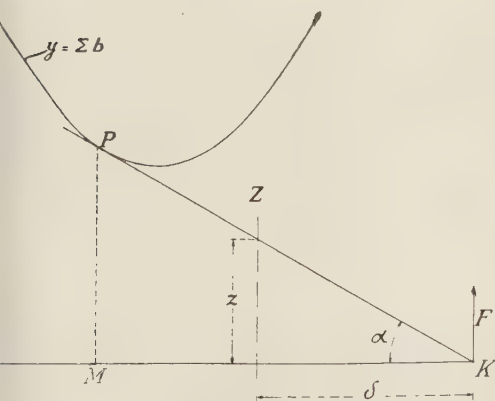


Fig. 12.

The moment of the resultant of the frictional forces in relation to an axis at any given distance δ from its alignment is measured in $2fQ$ units by the ordinate of the tangent corresponding to the y curve.

This property enables a new problem to be solved directly, namely to determine the centre of friction M for which the moment of the resultant F of the frictional forces in relation to an axis ZZ' is given and equal to z .

It is sufficient to draw a tangent to the y curve through the ordinate point z on the axis ZZ' ; the abscissa at the point of contact gives the required centre of friction M .

* * *

The value of x_1 being thus determined, it is easy to find the wheel contact angle θ which the wheel A makes with the outer rail for a curve of given radius ρ , the vehicle being assumed to occupy its stable position.

Indeed, we get

$$\sin \theta = \frac{x_1}{\rho}$$

If, for example $\rho = 300$ m. and a 4-wheeled vehicle having a wheel base of 2.25 m. is under consideration, it is found that $x_1 = 2.57$ m. and

$$\sin \theta = \frac{2.57}{300} = 0.00863$$

whence $\theta = 30'$ approx.

Incidentally it is seen that x_1 being constant, the value of the angle θ diminishes as the radius ρ increases, a result which, logically, would be expected.

The foregoing assumes that only the flange of the leading outer wheel A makes contact with the rail.

It is easy to check whether this hypothesis is true or not. In the above example we have as a matter of fact (fig. 13):

$$y = \frac{d(2x_1 - d)}{2\rho} = \frac{2.25(5.14 - 2.25)}{600} = 0.0108 \text{ m. (0.425 inch).}$$

y being smaller than the total play σ in the track, which is here assumed to be 25 mm. (0.984 in.) it is concluded that the trailing pair of wheels does not make contact with the inner rail and that the hypothesis initially advanced is justified.

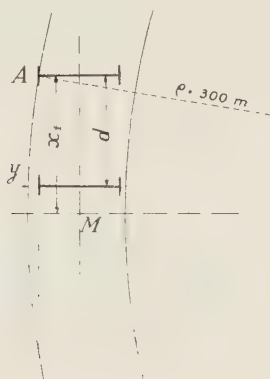


Fig. 13.

The radius ρ can be found, with which the flange of the inner wheel of the trailing pair of wheels begins touching the rail. This radius satisfies the equation:

$$\frac{d(2x_1 - d)}{2\rho} = \sigma. \quad (9)$$

σ being, of course, the appropriate value for the radius of the curve.

* * *

The case of the vehicle out of its stable position.

It has been established by the foregoing that in the case of an unbraked vehicle without driving wheels, running on a curve, the centre of friction M is

found on the centre line of the vehicle and its distance x_1 from the first pair of wheels is constant whatever the radius ρ of the curve and the value of the wheel contact angle θ at the outer rail.

It has also been established that with a given centre of friction M , the instantaneous centre of rotation O of the vehicle is on the perpendicular MO to the longitudinal centre line of the vehicle.

Let us consider a position of the vehicle (fig. 14) such that the angle of wheel contact at the outer rail is θ and the radius of curvature of the outer rail $\rho = AC$.

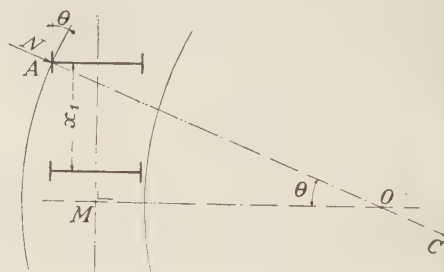


Fig. 14.

It is seen that the instantaneous centre of rotation of the vehicle, which is also found on the perpendicular on A , will coincide with C , the centre of the curve, only for a definitive value for θ , given by the equation:

$$\sin \theta = \frac{x_1}{\rho} \quad (10)$$

For this value of θ , O coincides with C . Now, the point C , which is the centre of the curve, is actually the instantaneous centre of rotation of the vehicle if

It should be noted that in the above calculation we have assumed ρ to be constant, but the differential equation (15) remains true if ρ varies as s .

* * *

In order to determine the stable position of the vehicle on the track, we have assumed up to now that the flange of only the outer front wheel A was in contact with the rail (the vehicle floating on the track).

But, this position being determined as has been shown, it is necessary to prove that the hypothesis made is true. To do this it is sufficient to calculate the ordinates of each of the wheels in relation to the rail.

Let us suppose that it is a question of proving that the wheel B does not make contact with the inner rail (fig. 16).

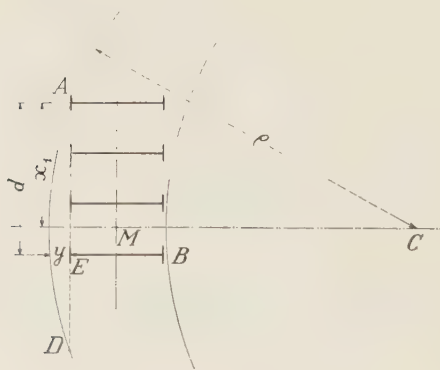


Fig. 16.

It will suffice, for this, to calculate the ordinate y of the opposite wheel E in relation to the outer rail.

Let σ be the total play of the pair of wheels on the track (gauge widening included).

We have

$$y(2\rho - y) = AE \cdot ED$$

and as y is negligible compared with 2ρ , we have

$$y = \frac{2x_1 d - d^2}{2\rho}.$$

In order that the wheel B does not make contact with the inner rail, it is necessary that

$$\frac{2x_1 d - d^2}{2\rho} < \sigma.$$

It is seen that if σ is constant, there is a certain value for the radius beyond which contact occurs.

In general σ varies with ρ , so that it is the product $\rho\sigma$ which determines the limiting case.

If one of the wheels, the wheel B for example, makes contact with the inner rail, the position of the vehicle no longer depends on the conditions of equilibrium which we have used till now. This condition is imposed by the track.

The conditions of equilibrium are satisfied owing to the reactions set up by the rail at the point of contact with the guiding wheels.

In this case the instantaneous centre of rotation O always coincides with the centre C of the curve, and the centre of friction M is at the foot of the perpendicular dropped from the centre of the curve, C , to the centre line of the vehicle.

By a similar calculation to that above, it is found that the distance from the centre of friction to the first pair of wheels is :

$$x_1 = \frac{2\rho\sigma + d^2}{2d} \quad . \quad . \quad . \quad (17)$$

Calculation of rail reactions.

As we have seen, a frictional force fQ is set up between the upper surface of the rail and the tread of each wheel, and the direction of these forces varies for each wheel.

When a wheel makes contact with either the outer or the inner rail, the rail exerts a reaction at right angles to the flange of the wheel. The force that the rail then exerts on the wheel is, therefore, the resultant of a force fQ and of this perpendicular reaction.

In view of what has been explained previously, we will assume the rail reaction, not to be at right angles to the rail, but following the centre line of the axle. This amounts to disregarding the influence of the angle θ and, at the same time, the force required to move the vehicle.

The value of this reaction Y is deduced from an equilibrium equation. If the vehicle is floating on the track, the reaction Y is equal and of contrary sign to the resultant of the frictional forces F , which resultant we have determined previously. The centre of friction M has to be determined, first of all, by the condition that this resultant must pass through the centre line of the first axle.

If a second wheel B makes contact with the inner rail, (fig. 17), that is to say,

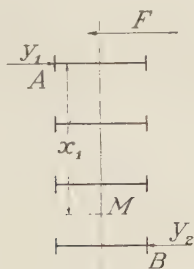


Fig. 17.

if the position of the vehicle is governed by the track, there are two reactions to be determined, Y_1 and Y_2 .

The centre of friction is directly determined by equation (17)

$$x_1 = \frac{2\rho\sigma + d^2}{2d} \quad (17)$$

and to this centre M corresponds a resultant F of the frictional forces, the position and magnitude of which are easily calculated.

It is, therefore, sufficient to calculate the value of the forces Y_1 and Y_2 , the alignment of which is known, for them to balance the resultant F .

Y_1 and Y_2 are thus determined without difficulty.

It is obvious that in the case considered F is always found in front of the first pair of wheels.

* * *

We have considered up to now only the case of a vehicle with its pairs of wheels mounted in an ordinary rigid underframe, without lateral play (the case, for example, of tender wheels — except for a ± 1 millimetre clearance), the tyre flanges of which all had the same contour.

It is sometimes an advantage to deviate from this rule.

The use of tyres with thinned-down flanges on intermediate wheels can be justified by the following considerations. The pair of wheels which first comes in contact with the inner rail, when the radius ρ decreases, is the trailing pair of wheels, and it is necessary to consider two reactions, Y_1 and Y_2 .

If the radius ρ decreases further, there comes a time when the penultimate pair of wheels will make contact with the inner rail, the trailing pair of wheels ceas-

ing to be in contact with this rail. It can be easily proved that the reaction of the rail on the penultimate pair of wheels has a greater value than Y_2 . It is therefore desirable to put off as long as possible the moment when the wheel of the penultimate pair touches the rail, and this is done by reducing the tickness of the flange.

This reduction cannot exceed a certain limit, so it may happen that the minimum radius of the curve under consideration is such that, in spite of the maximum reduction in the tickness of the flange provided, the wheel of the penultimate pair continues to make contact with the inner rail.

In this case the frictional forces fQ applied to the trailing axle tend to thrust it towards the inner rail and this thrust has the effect of increasing the reactions Y_1 and Y_2 .

This thrust can be suppressed by giving lateral play in the underframe for the trailing axle, allowing the wheel to make contact with the rail (fig. 18).

Lateral play can also be given to the penultimate pair of wheels, the last pair being without play.

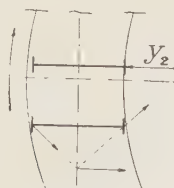


Fig. 18.

The calculations of the reactions must obviously take into account these factors, but the problem is always solved by equilibrium equations.

* * *

Here is an example applying the theories set out above.

An unbraked locomotive bogie, having two pairs of wheels 2.25 m. apart and each loaded with 14 tonnes works round a curve. It is subjected to a controlling force of 4 000 kgr. at the centre pin. The leading outer wheel only is assumed to make contact with the rail (fig. 19).

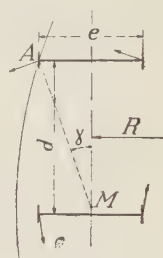


Fig. 19.

Where is the centre of friction ?

We will take as coefficient of friction $f = 0.25$; consequently $fQ = 1\,750$ kgr.

The centre of friction M is situated on the centre line of the vehicle since there is no tractive effort or braking force.

The position of the point M on this centre line is determined by the condition that the resultant of the corresponding frictional forces fQ and the controlling force R must pass through the point A .

The point M can be determined in two ways, by calculation or graphically.

By calculation we proceed by trial and error, giving an assumed value for x_1 .

The resultant of the forces has a value of

$$\Sigma fQ \cdot \cos \gamma + 4000.$$

Its moment about the point M is equal to

$$\Sigma fQ \cdot b + 4000(x_1 - 1.125).$$

with all questions relating to the working of vehicles on curves, even when several vehicles are interdependent, as is the case, for example, of a locomotive fitted with a bogie in front and a bissel truck behind. The whole then comprises three vehicles joined by pivot pins and subjected to reciprocal reactions, namely, centering forces.

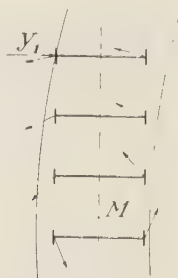


Fig. 21.

In such cases the calculations are fairly long, but they present no difficulty. Care should be taken to consider each vehicle separately with the forces which apply to it.

Very interesting examples were given in UEBELACKER'S original memorandum (*Organ*, 1903).

The theory of the circulation on curves presents further interest from other points of view.

Let us consider, for example, an 8-wheeled vehicle in its floating stable position (fig. 21).

The reaction at the rail in front is Y_1 , which includes the frictional force fQ .

The other wheels do not make contact with the rail but they are each, however, acted upon by two forces fQ , the components of which, in a direction parallel to the centre line of the axle, are the greater the further the axle is situated from the centre of friction M .

The thrust on the second pair of wheels may have a considerable value and, as it acts continuously even on curves of large radius, it is necessary to keep this in mind in order to prevent wear of the checking surfaces. This thrust is particularly dangerous when the thickness of the flanges of the second pair of wheels is reduced, which is sometimes done so that the engine can be worked backwards. The distance from the flange to the rail is occasionally from 10 mm. to 15 mm. ($3/8''$ to $5/8''$).

Such wear can be remedied by arranging for the tyre of the second pair of wheels to make early contact with the outer rail. The reduction in the tickness of the flange is restricted to the necessary minimum, and play is given to the second or first pair of wheels.

This theory also enables all the forces to which the underframe of the vehicle is subjected by reason of its passage over the curve to be found (see *Bulletin of the Railway Congress*, September, 1929).

The investigation of these forces is above all useful for vehicles such as the bogies of carriages or wagons, because there is usually a tendency to underestimate their value, their small wheel-base leading to the supposition that their passage over a curve is made without any effort.

The calculation of the wheels must also take into account the reactions we have studied.

The case of vehicles the wheels of which develop tractive efforts or braking forces.

If only the leading outer wheel A makes contact with the rail, in order to determine the stable position of the vehicle

The equation (22) then becomes, after substitution :

$(\xi - x) \cos \alpha + (\eta - y) \sin \alpha + a = 0$
or
 $\xi \cos \alpha + \eta \sin \alpha = x \cos \alpha + y \sin \alpha - a$
or
 $\xi \cos \alpha + \eta \sin \alpha = ON - KN = OK.$

It is seen, therefore, that the intersection of the plane tangent to the horizontal plane coincides with the alignment of the resultant F.

The tangent of the angle δ which the tangent plane makes with the horizontal plane can be expressed in two ways, which lead to the equality :

$$\tan \delta = \frac{\partial \pi}{\partial a} = \frac{\pi}{a}$$
or
$$\frac{\pi}{a} = F,$$

and consequently

$$F = \frac{\partial \pi}{\partial a} \quad . \quad . \quad . \quad (23)$$

The resultant of the frictional forces F is, therefore, equal to the partial derivative of π taken in relation to the horizontal direction which is perpendicular to it.

Moreover, we also have

$$F = \sqrt{\left(\frac{\partial \pi}{\partial x}\right)^2 + \left(\frac{\partial \pi}{\partial y}\right)^2} \quad (24)$$

It results from the above that for each point *M*, considered as a centre of friction, there is a corresponding resultant of the frictional forces *F*, the alignment of which is given by the intersection, with the horizontal plane, of the plane tangent to the π surface at the point projected horizontally on *M*. This resultant

of the frictional forces is measured by the tangent of the angle formed by these two planes.

Inversely, if the alignment of the resultant *F* is given, the centre of friction which corresponds to it is the projection *M* of the point of contact with the plane drawn tangent to the π surface and passing through this alignment.

The resultant *F* is measured by the inclination of this tangent plane on the horizontal plane.

In this way, the principles which served as the basis of HEUMANN's outline are generalised.

An example showing the application.

Let us consider a locomotive having six coupled wheels on a leading bogie, the pivot of which is found at *P* (fig. 24). The 3 pairs of coupled wheels are considered to be floating on the track and guided only by the bogie pivot where the controlling force is developed.

These conditions imply that the resultant of the frictional forces *F* always passes through *P*, whatever tractive effort *T* is developed.

If this tractive effort *T* is nil, the centre of friction *M* is found on the centre line of the vehicle. In proportion as *T* increases, *M* deviates from the centre line towards the left and occupies a position to be determined.

We shall find it by tracing two geometrical loci from the point *M*.

If we give an arbitrary direction of the resultant *F*, the centre of friction *M* will be, as we have seen, the projection of the point of contact with the plane tangent to the surface π and passing through the straight line *F*.

If it is imagined that the straight line *F* turns round the point *P*, through which it must pass, it is seen that a first

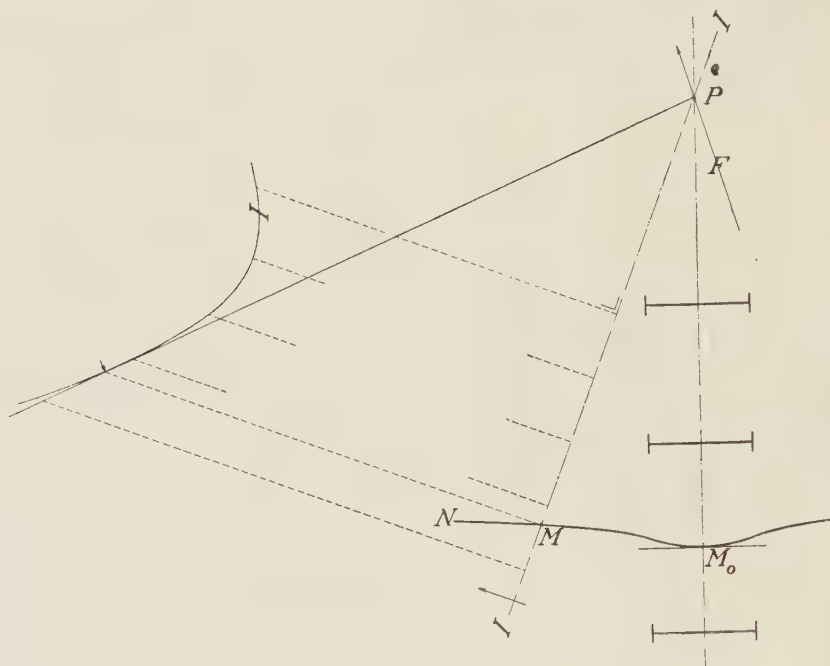


Fig. 24.

geometrical locus from the point M is the projection of the apparent contour of the \mathfrak{M} surface, as seen from the point P .

If through the point P the \mathfrak{M} surface is cut by a vertical plane II , the intersection of this plane with the \mathfrak{M} surface can easily be traced through points lowered on to the horizontal plane.

Thus the curve I (fig. 24) is obtained.

A tangent to this curve is drawn through P and the projection of the point of contact on the axis II gives a point M of the required geometrical locus. As many sections as may be desired will be made to obtain points of the locus.

Each point of this geometrical locus M_o M N gives a resultant of the frictions passing through the pivot P , but the corresponding tractive effort varies in accordance with the position of the point on this curve.

We now have to determine a geometrical locus of the points M , corresponding to a given tractive effort such as

$$T = k \cdot fQ$$

T is the projection, on the axis of the x -es, of the resultant of the frictional forces; we have therefore (20) :

$$T = \frac{\partial \mathfrak{M}}{\partial y} \cdot fQ$$

Let us consider any point M (fig. 25). Let us draw a transverse vertical plane II . The intersection of this plane with the \mathfrak{M} surface is easily determined by points and can be drawn by projecting it down to the horizontal plane. Thus the curve I is obtained (fig. 25).

The point M will satisfy the condition if the tangent drawn from M' to the curve

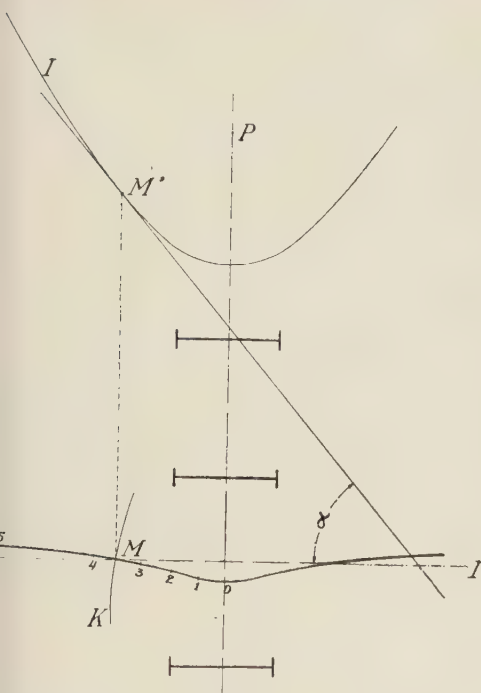


Fig. 25.

makes an angle α with the axis $I I$, so that

$$\tan \alpha = k.$$

We can immediately deduce from it the outline of the geometrical locus of the points M corresponding to a definite tractive effort :

$$T = k \cdot f(Q).$$

This second geometrical locus has the aspect of the curve MK . The intersection of the two geometrical loci MN , MK , gives the required point M .

The above graphical process has the advantage of great clearness in the operations. It is essential, however, that the diagrams be made with the greatest care and that the scales be suitably chosen. As a matter of fact, it is a question of finding points on curves where the curvature is sometimes very small.

Figure 25 gives the first geometrical locus on which have been marked the positions 0, 1, 2, 3, 4, 5, of the centre of friction for the tractive efforts $T = 0$, $T = fQ$, $T = 2fQ$, etc.

Tickets,

Continued (*)

by LIONEL WIENER,
Professor at the University of Brussels.

PART E.

TICKET REPRESENTATION OF TARIFFS.

In addition to local or through single and return tickets issued in each class at normal fares, a number of tickets of all kinds are issued at reduced or increased rates either to all or to certain classes of passengers only. Dealing with these tickets would take up too much

space, so we have relegated the matter to an appendix, which will appear in due course. This will also deal with all kinds of supplements, with tickets for the conveyance of animals and objects, toll charges and auxiliary services.

* * *

PART F.

CHECKING AND STATISTICAL FUNCTION OF TICKETS.

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(*) See *Bulletin of the Railway Congress*, March, May, and July 1938, pp. 217, 473 and 665 respectively.

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CHAPTER XI.

PRECAUTIONS AGAINST
FRAUD AND FORGERY.

1. **General considerations.** — As the Companies protect themselves against forgeries, the staff can have confidence in the ticket produced by passengers.

The ticket itself must admit of double checking by the passenger and by the staff, and provide all the elements of the journey it applies to. This must be done without making it too complicated; it cannot be too strongly emphasised that the merit of any system resides in its simplicity. If there were fewer types of tickets there would be fewer chances of mistakes occurring.

Forged tickets have appeared occasionally but are little to be feared for short distances because the risk run by forgers is too great and the profit to be gained, too small. It is quite a different matter, however, when long journeys are involved, as in America and on the Continent, and elaborate precautions are taken, particularly in America, against anything of the kind.

But has it been realised how simple it would be, instead of printing false tickets, to produce booklets under the name of some imaginary ticket Agency? If the simple precautions of tearing out the first two or three leaves were taken, as if the booklet had already been partly used, it would not occur to any railway

servant to verify whether such an Agency really existed or not. As the tickets issued by the various Agencies differ from each other and the railway's own booklets even differ according to the route, there would be no difficulty about producing such booklets. To avoid this happening, strict standardisation should be enforced.

European checking methods inevitably reveal false tickets after a time and before their use has reached a disturbing figure. Where several journeys can be made on one ticket more efficient means of protection, such as safety backgrounds and other devices are called upon. In America, where distances are often considerable and the fares correspondingly high, an appreciable loss would be caused by the use of even a single false ticket. This is why Companies take such strict protective measures; whilst more costly than those used elsewhere, they are also more effective and more thorough.

Let us consider, as an instance, rapid transit passes. On the Continent, they are usually quite simple. Not so in America where the following precautions against fraud are taken :

Printing is done in several colours.

A safety background is used.

Colours vary from week to week.

Besides the number of the week and the date, a symbol is clearly printed.

This is changed weekly and may refer to the week, the route, or the class of season ticket.

The period of availability and date of expiry are printed in large type.

From time to time, the style of printing and even the shape of the pass are altered.

Some Compagnies use different colours for their season tickets on each route and even change them weekly, the same colour not reappearing before the expiration of three weeks. Additional symbols are printed for some routes, for others, not.

Generally speaking the following means of guarding against fraud are resorted to :

- Safety (watermark) paper.
- Safety backgrounds and grids for writing upon.
- Secret markings.
- Markings guaranteeing the genuineness of tickets.
- Constancy of the aspect of the tickets.

2. Use of special papers. — These are hard to secure fraudulently; those supplied by others than the original makers always differ from the standard stock. In America, such papers are produced by special processes, their manufacture is carefully supervised so that their quality

is constant and their appearance, uniform.

We considered them in Chapter II, more particularly on pages 237 (21) to 242 (26).

3. Safety backgrounds are used so as to render the forger's task more difficult both when printing a false ticket and when altering an ordinary one fraudulently.

The safety background is usually printed in a second colour or a different shade of the same one, and consists of a design covering the whole or part of the ticket. It is frequently used on card or paper tickets, less often on Edmondsons (fig. 428).

Continuous safety backgrounds. — EDMONDSON TICKETS are occasionally over-printed with a supplementary impression which completely alters their appearance.

(a) In Italy and in Rumania a very fine and close squared ruling is added. The shade of the colour looks different with it. More important still, it effectively prevents any fraudulent interference.



Tickets with safety backgrounds. (Red. 4/5).

- Fig. 427. — *Rumanian State Railways* — With black square hatching.
- Fig. 428. — *French Nord Railway*. (The background has been brought out).
- Fig. 429. — *Isle of Thanet Electric Tramways* — Background formed of letter repeated on diagonal lines — Category : Exchange ticket.

In Italy, the colour of the overprint varies with the class of the ticket (1st, 2nd and 3rd) (*fig. 230*). In Rumania, it is always black (*fig. 427*).

(*b*) In Japan, and recently in England, on the *Southern and Great Western Railways*, on blank or semi-blank tickets, a coloured design covering the entire ticket is printed over a paler background (*fig. 433*).

(*c*) The so-called Orloff design was used in Russia and in Finland before the War, and printed on tickets of the three classes. The background was formed of three separate designs, two of which were printed in interlaced colouring on a tinted ground while the third was a repetition of the number indicating the class which showed up in white (*figs. 431 and 432*).

The *Arkhangel Railway* only used two interlaced colourings and no class figures at all (*fig. 430*).

(*d*) In the States, a machine-lithographed safety background is often to be found; it consists in a complicated intaglio design or guilloche standing out in white against a delicately coloured background, with or without facsimile of an official's signature or the Company's initials in the centre ⁽¹⁾.

The design and colour are not necessarily the same on both sides of the tickets (*figs. 435 to 437*), some having the design on the front only ⁽²⁾, others only on the back. It would be practically impossible to imitate or tamper with them. In addition, the facsimile signature would have to be forged, which would entail additional legal penalties if detected.

The workmanship of all these tickets is remarkable.

Similar designs, though of less fine a character, have been made in typography in Europe (*figs. 438, 439*), even for City transport coupons (*figs. 361, 391, 392*).

Besides the above, other continuous backgrounds may be obtained in a number of ways, such as :

Repetition on successive lines of the Company's initials.

Repetition of class initial (*fig. 429*).

Rows of lines or hatchings, or surface grain-ing.

White dots, broken into or not by the Company's initials.

White design standing out on the coloured background (*fig. 428*).

A design covering the whole surface of the ticket.

PAPER TICKETS. — Besides a background made up of repeated initials (*fig. 280*), the railway's crest or monogram, or various designs worked into a continuous background are often to be found (*figs. 362 and 371*).

The continuous background of American sheets of coupons is frequently broken by text in negative type.

FREE PASSES AND MULTI-JOURNEY TICKETS have a background lithographed in one or several colours; its complication may be increased by leaving blank spaces. The « Setright » and « Automaticket » machines coupons and tickets have similar backgrounds (*figs. 401, 402 and 380*).

A double sided carbon is used when necessary, as it transmits the indications on the duplicate copy and on the back of the ticket itself, thus successfully preventing any misuse.

(1) The *Chicago, Rock Island and Pacific Ry.* uses the most varied combinations, in particular pink and pale green; azure and canary yellow; grey and pink; buttercup yellow and olive green.

(2) *Alabama and Vicksburg Ry.*



Multicolour safety backgrounds of Edmondson tickets. (Red. 4/5).

Fig. 430. — Bi-colour back of an *Arkhangel Railway* ticket (1908).

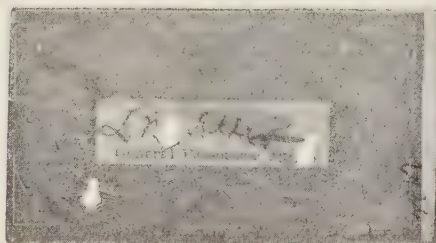
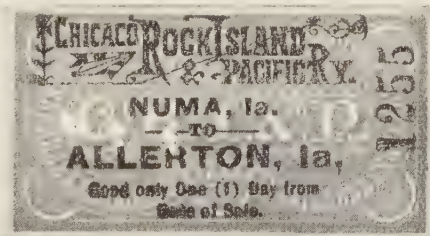
Figs. 431 and 432. — Three-colour backs of 1st and 2nd-class tickets of the *Russian Imperial Railways*. This is the so-called Orloff design.

Fig. 433. — Present monochrome safety background used on blank tickets, *Great Western Railway* — The background has been brought out.

Non-continuous safety backgrounds are formed of various designs containing the initials of the Company, with suit-

able ornaments; they are often used on multi-trip tickets (*fig. 344*).

American Edmondson tickets sometimes



Guilloche safety backgrounds. (Actual size.)

Fig. 434. — Multi-coloured monogram — Dated by perforation.

Figs. 435 and 436. — Back and front of a *Chicago, Rock Island & Pacific Ry.* ticket — Facsimile signature of General Passenger Agent.

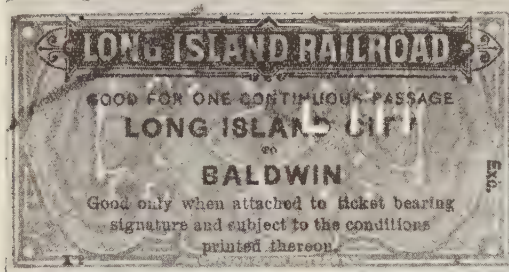


Fig. 437. — *Long Island R. R.* coupon with guilloche background. (Actual size) — Printed by *American Bank Note Co.*

bear a guilloche design covering part of it only (figs. 382 and 436). A cheaper looking design of the kind may be obtained by typography, and is to be found on tramway and multi-trip tickets in Berlin, Potsdam and elsewhere (fig. 221).

Tickets issued by urban transport undertakings frequently bear a safety background consisting in a coat of arms, or the picture of one or other of the city's monuments (figs. 387, 440).



Metropolitan railway tickets, with Company's name left white in guilloche background. (Red. 4/5).

Fig. 438. — Front of first *Central London Ry.* tickets.

Fig. 439. — Back of first *Paris Metropolitan* tickets (1900).

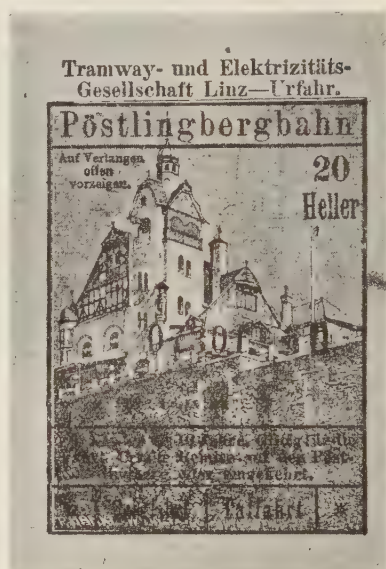


Fig. 440. — Safety background consisting of a picture of a building on the line — *Pöstling Mountain Railway*, near Linz, Austria. (Background brought out).

SAFETY GRIDS. — Blanks and semi-blanks whereon particulars are to be added in writing or printing are provided with ruled or hatched spaces (grids) as a guarantee against fraudulent alteration (figs. 243, 280 and 378).

There are from 1 to 4 and sometimes as many as 5 grids to a ticket (fig. 228). These grids are generally formed of 4 to 6 straight or parallel wavy lines, more or less widely spaced (fig. 93) or by the Company's interlaced initials (*Paris Ceinture*).

The *P. L. M.* prints green grids on its tickets, where the particulars relating to the journey have to be entered.

When space is lacking, the grid is placed parallel to the long side of the ticket; the fare may be entered or the name of an extra station or halt which has not been included among those preprinted on the ticket (fig. 195).

The Swiss paper blanks have three grids of different colours, one for each class travelled in. This allows of the destination being entered on the grid corresponding to the class of carriage applied for (fig. 279).

When elements are shown by perforation instead of writing, such as the « Bell Punch » cancellor's (figs. 20, 220)



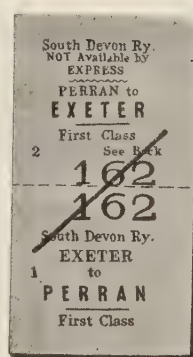
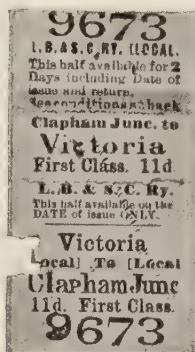
English tickets with names of stations including so-called safety letters. (Red. 4/5).

Fig. 441. — Great Western Railway ticket (in the fifties) — Gothic type letters in « Paddington » — The letter (H) is the printer's initial — Price added by hand, if required.

Fig. 442. — London, Brighton & South Coast Ry ticket — Capital letter in the word « Bridge ».

different grids are prepared. They are formed of a repeated figure (corresponding to the value) or of letters varying with the class of ticket or the section travelled over. It is clearly impossible to alter such a perforation fraudulently.

BACKGROUND DESIGN FOR SPECIAL CLASSES OF TICKET. — So as to recognise certain



Edmondson tickets. (Red. 4/5).

Fig. 443. — Suburban return ticket, London, Brighton & South Coast Ry., with « safety » capital letter (P) in the word « Clapham ».

Fig. 444. — South Devon Ry. express train return ticket (late fifties) with halves numbered « 1 » and « 2 » — Serial numbered in the middle.

classes of paper or Edmondson tickets at a glance, they are frequently lithographed, before printing, with a suitable design such as a dog (fig. 627) or a cow, for drover's tickets.

4. Secret markings. — The December 1909 issue of the *Bulletin of the International Railway Congress Association* mentioned a number of secret signs some of which, such as the « combinado » sign in Morse on the back of Spanish through tickets, are decidedly odd.

Several British Companies have made use of simple and obvious signs, deliberately including type from a different fount in the text of the ticket and particularly in a place's name. Figures 441 to 443 show some very curious examples; capitals in place of lower-case letters, and gothic type in place of capitals.

It has always been asserted that the French *Nord Ry.* at one time used secret signs as a regular practice ⁽¹⁾. But so

(1) Report by Herr von Stierlin on the question of PASSENGER TICKETS. Berne International Railway Congress, 1910.

secret were they, that since a long time no one seems to know what they were.

5. **Constancy of the aspect of tickets.** — This is only obtained by always arranging the text in the same way and by using standard paper and identical colours, which only occur with first-class products. There is no need to emphasise that this is seldom the case. However, the very fine finish of the *P. L. M.* and *Swiss Federal Rys.* tickets, as well as those issued by a number of North and South American Companies such as the *Anglo-Chilian Nitrate Railways*, should be mentioned. All this tends to prevent fraud, not only in invariably maintaining the appearance of the ticket, but also because it is much harder to imitate a good production than a bad one : for the latter an approximate imitation would suffice, since inaccuracies in the shape of the type exist in the mediocre tickets that might be imitated.

CHAPTER XII.

GUARANTEES AGAINST IRREGULAR USE.

Before issuing a ticket a series of operations must be gone through to make it valid for the carrying of a stipulated passenger, under Company's bye-laws over a given distance. It is necessary :

(a) To render the piece of printed paper valid as a ticket which it is to become;

(b) To identify this ticket with the line on which it is to be used;

(c) In addition, to identify the passenger as holder of such ticket;

(d) To identify the abstract ticket, which has thus become valid, as a ticket held by a passenger, with the journey the holder intends to undertake.

We shall refer under a special heading to such of these operations as can be performed mechanically.

A. — RENDERING PRINTED PAPER VALID AS A TICKET.

In addition to fixed destination tickets, it was customary to use, in the earliest days of railways, blank or semi-blank tickets, which were filled in and completed by hand. This took up time, so that certain particulars were lacking on the first British Edmondson tickets. The serial number appeared but neither the date, the fare, nor the Company's name. Certain tickets only gave the journey, the serial number and the class of carriage (*fig. 54*). Strange as it may seem, the same happened in America where these practices were longer lived than with us.

It was long the custom in the United States to use un-numbered thin card tickets bearing only the vaguest particulars; these tickets were collected at the end of the journey and used again indefinitely. They were in fact but counter-marks, and bad ones at that, because no real check could be kept on their use (*figs. 445 and 446*). Having purchased from John Edmondson the exclusive rights concerning his presses, dating apparatus and ticket holder frames, Bailey set up a ticket printing establishment at Buffalo in 1855 and thereafter, card tickets were known by his name in America ⁽¹⁾.

As the name of BAILEY was associated with the earlier American cardboard tickets, we will give a few particulars of his career as we previously did for

(1) Pages 245 (29) et seq.

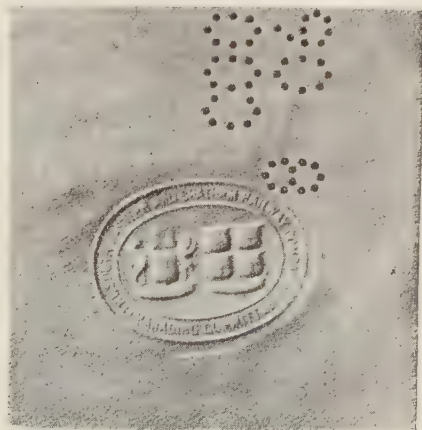
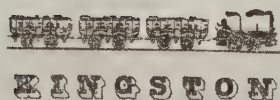
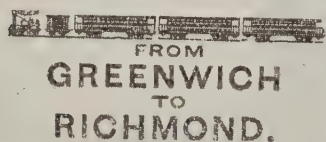
EDMONDSON, when discussing the first English tickets ⁽¹⁾.

1. **Guarantee markings.** — A mere printed slip becomes a true ticket with a sale value directly it is marked with the Company's stamp. Almost all European coupon booklets and booklets of combined coupon tickets are marked with a dry stamp (fig. 447). Even Edmondson

tickets used to be stamped in this way. In other cases, ink stamping in colour is used (figs. 461, 243 and 349).

The name or initials of the Company are also type-printed or lithographed on the back of tickets. This practice, formerly widely used in England (figs. 448 and 450), subsists in British India and the River Plate (fig. 453).

FACSIMILE SIGNATURE (« GRIFFE ») OF THE COMPANY'S REPRESENTATIVE. — So that the passenger may know that the tickets are issued in conformity with the Company's regulations they all bear in



Figs. 445 and 446. — Old American tickets (early fifties) — With vignettes and facsimile of signature — Neither dated nor numbered. (Red. 4/5).

Figs. 447. — Company's arms impressed by dry stamp on a coupon from a booklet — *South Eastern & Chatham Ry.* — Dated by perforation. (Full size).

(1) Bailey took Julius Movious and William R. Barr, both of them railway officials, as partners. They started with two presses which they imported in 1855. Their first tickets were supplied to the *Boston and Worcester R. R.* (later amalgamated with the *Boston and Ohio*), then to the *Pennsylvania R. R.*, to the *People's Line Steamers*, etc. Their undertaking developed slowly owing to their prices being excessive : \$ 1.00 per 1,000 tickets advanced to \$ 1.25 in 1862, during the Civil War. They then owned five presses turning out 6,000 tickets an hour; this was to become 15,000 in 1900. These high prices led to competition. *Sanford, Warren & Harroun*, of the « *Buffalo Courier* », financed the inventor George J. Hill who got round the patents and printed larger tickets at half the speed, but also at half the rate. Bailey retired in 1882, lost his fortune shortly after, and having gone to live in York, England, died in want. These and certain other particulars are taken from an interesting pamphlet written by Mr. Robert S. Gardiner, formerly president of the *Rand Avery Supply Co.*, Boston. Figures 445, 446, and 461 to 464, are also taken from this booklet.



Old English tickets (in the fifties) bearing Railway Company's monogram or ornamental crest on the back. (Red. 4/5).

Fig. 448. — *London & North Western Ry.*

Fig. 449. — *Great Northern Ry.*

Fig. 450. — *North Staffordshire Ry.*

America the printed facsimile signature of the principal operating officer (*figs. 15, 18, 332*).

Elsewhere it is considered sufficient

for the ticket to bear the principal conditions under which it is issued, or a declaration that it is issued in conformity therewith.

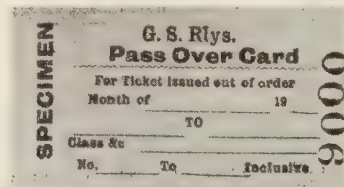


Fig. 451. — Ticket with crest of the *Rhein-eisenbahn Gesellschaft* (1885) — Date dry-stamped.

Fig. 452. — Ticket with crest of the *Link-rhein Eisenbahn Gesellschaft* (1885) — (Red. 4/5) — Date dry-stamped.

Fig. 453. — Complimentary ticket — *Central Argentine Ry.* — Monogram lithographed in colour on back. (Red. 4/5).

Fig. 454. — Pass over card replacing ticket issued out of order — *Great Southern Rys.* (Ireland).

As a matter of fact, the Company's name which appears very clearly on the ticket covers this requirement.

2. **Numbering of tickets.** — Serial numbering of tickets allows of :

(a) Checking the deliveries made by the printing works to the booking offices and apportioning to the latter the ticket value they have received and are responsible for;

(b) Ascertaining rapidly the number and value of the tickets remaining in the holders, of those issued to the public, and of cash received for them;

(c) Checking the number of tickets issued by the booking offices with the payments made by them to the chief cashier.

These various operations are performed mechanically in ticket printing machines when issuing a ticket. We shall mention them again in Part I.

It is curious to note that on Edmondson return tickets with separable halves the number of the ticket was sometimes printed in the centre (figs. 155, 184, fig. 444). This practice, which dated from the middle of last century, did not last long.

As part of the ticket might be severed, it was customary to print the number at each end, but when tickets were to remain whole, the number was printed at the bottom only and the date at the top. This upper space is sometimes divided between the date and the number, the latter being printed in smaller type beneath or next to the former (fig. 261 and the A. E. G. tickets, figs. 231 and 233).

On some tickets, the number is printed in small type on one side of one of their

parts or if need be, on both of them (figs. 230 and 265).

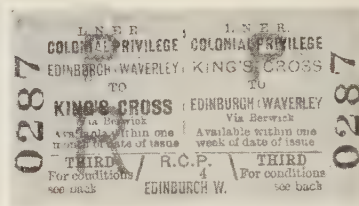
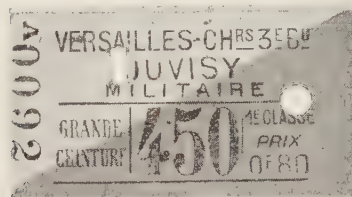
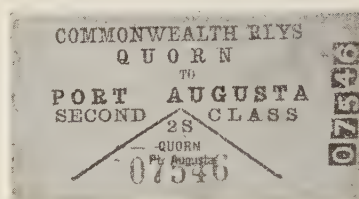
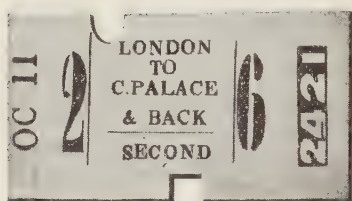
Although ticket numbers are generally formed of four figures, numbers of five (*Austrian Federal Railways*) and even of six figures occur ⁽¹⁾.

The English serial numbering commences with a « 0 » whereas on the Continent, the first number is « 1 ». The English method is more rational and above all more practical; with it, a series of 10,000 numbers runs from 0 to 9,999, all four-figure numbers, while on the Continent it runs from 1 to 10,000 giving four-figure numbers with a five-figure one at the end unless the series be limited at 9,999 and contain 9,999 numbers only instead of 10,000.

In England and America numbers are printed indifferently in positive or in negative type (fig. 178). They occasionally occur in red (*Reichsbahn*). On the *Queensland Rys.*, in addition to the usual number in black, there is another in red on the lower middle part, which is punched out when the ticket is issued to a child (fig. 457).

For a reason known to the printer or the accountancy department a certain ticket number may be lacking. To avoid complicating the records, a ticket having no value for transport, called a pass over card (fig. 454) or dummy ticket, is then provided in its stead. This applies to an authorised missing number, but it is another matter when a ticket is irregularly extracted from the middle of a packet, where it would not be detected for some time. But with tickets made up in rolls, or folded zig-zag in strips, a ticket can only be removed from the ends.

(1) The *Tunisian Railways* have five-figure numbers, the *P. L. M.* and *P. O.*, six-figure numbers. These were also used on the exchange tickets of the old *Parisian Nord Tramways* as well as on American and Canadian paper tickets, and interurban or railway transfers.



Edmondson tickets (Red. 4/5).

Fig. 455. — Old London, Brighton & South Coast Ry. ticket with large numbers of departure and arrival stations — As little text as possible.

Fig. 456. — Bi-coloured Grande Ceinture Ry. ticket — With destination station number — Company's name — Category: Military.

Fig. 457. — Queensland Rys. ticket with triangular child's portion, bearing serial number besides the usual particulars: class, name of issuing and arrival stations.

Fig. 458. — L. N. E. R. return ticket with four-sided child's portion — Category: colonial privilege ticket.

3. Stubs, counterfoils and coupons. — A portion is detached from tickets to prove their sale or to enable receipts to be appropriated according to the route actually followed by the passenger.

Pieces and stubs of various kinds are detached from Edmondson tickets. These consist in:

- (a) Auditor's stub of blank ticket.
- (b) Piece punched out of a ticket issued to a child.
- (c) Stub detached from fare scale tickets.
- (d) Control stub for alternative route.

(a) AUDITOR'S STUB OF EDMONDSON BLANK TICKET. — This is removed from a standard size or lengthened ticket (figs. 63 and 265), and serves to justify the booking clerk's issuing of the ticket at less than full fare.

(b) THE CHILD'S STUB is punched out of

English single and return tickets and retained by the booking clerk; it bears the name of the destination station and the number of the issuing one (figs. 236, 237, fig. 439). Elsewhere a full-fare ticket is bisected for issue to a child (figs. 217, 695). This is done by machine in England (fig. 400), by hand in Belgium and Hungary, across a preprinted dotted line (figs. 194, 201).

(c) FARE-SCALE TICKET STUBS. — With the help of the stub, it is easy to check the fare for which the rest of the ticket has been sold (figs. 227, 230).

This stub is removed by means of scissors, or as in Belgium by means of cutters (figs. 231 and 696).

(d) ROUTE STUBS. — The simplest of these are the outward and return portions of return tickets which are detach-

ed and retained on the way. The same process applies to three-portion tickets when each part corresponds to one of the sections of a journey. This also occurs on road transport (*fig. 187*).

The COUNTERFOILS OF PAPER TICKETS reproduce the particulars needed for auditing as do triplicates (*fig. 192*). The particulars are transmitted by perforation through duplex and triplex tickets, the part not given to the passenger bearing the curious but correct statement :

This portion of the ticket is of no value except to the conductor... (*fig. 226*).

American paper strip tickets always have a stub, at the end of the strip, beyond the first coupon to be detached. The particulars are transmitted, often in duplicate, by clipping. Season or multi-trip tickets are also provided with an Agent's stub (*figs. 342 and 353*) and sometimes with a special Auditor's stub as well (*figs. 150 and 341*).

Two portions of return tickets are given to the passenger (*fig. 52*). In both cases there is often a supplementary outer portion which is a check to be detached by the first conductor. This practice is used in Europe for blank paper tickets, but here the stub is withdrawn when passing onto the platform (*fig. 93*).

Many European paper tickets, sheets or books of coupons have a stub which is detached, and sent to the auditing department when the ticket has been sold to a child or at half the fare. This stub is generally triangular in shape (*figs. 92 and 425*), occasionally vertical in certain booklets of coupons.

CONTROL OR CHECKING COUPONS. — When

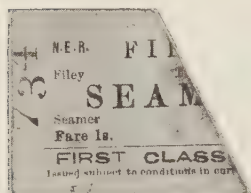
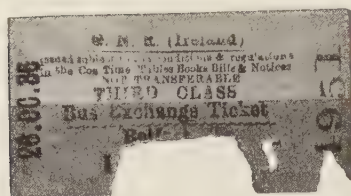
a passenger may choose between routes operated by different Companies, or, between which, if belonging to the same Company, it is necessary to establish a distinction for accountancy and statistical purposes, Edmondson tickets are provided with check portions; their length or breadth is increased so as to turn them into what we have dubbed « multiple Edmondson tickets » (*figs. 67 and 68*).

When required, « combinable » paper tickets are provided with perforated coupons (*fig. 91*). Thus the single coupon leaflet for the Dover-Brussels section is subdivided horizontally to separate the sea from the land journeys, and each of these halves has a smaller triangular coupon for use when issued to a child.

SECTIONAL JOURNEY COUPONS. — Although Edmondson tickets, known as Bailey tickets in America, were introduced into the States for covering journeys over the metals of one system only, economic conditions obtaining there so frequently obliged passengers to travel over several different railways that the Companies had to work out new methods for multi-line trips ⁽¹⁾.

The English Railway Clearing House had been established as a result of an act of Parliament, passed in 1850, which authorised journeys over more than one Railway to be made under the same conditions as those confined to one line only. Actually the new through fares were arrived at by merely adding the fares over the constituent lines forming the shortest route. Issuing stations sent the Clearing House particulars of their ticket sales for checking against the collected tickets that went straight to it. As the ticket nippers used by the various Com-

(1) Some of the following particulars are taken from Robert S. GARDINER's book.



Edmondson children's tickets. (Red. 4/5).
 Fig. 459. — *Great Northern Ry.* (Ireland)
 — Motor bus exchange ticket — Child's portion punched out.
 Fig. 460. — *North Eastern Ry.* — Bisected child's ticket.

panies punched their own distinguishing marks out of the tickets, or impressed them with a number or letter designating the stations of the various Railways involved, it was easy to calculate what proportion of the fare was due to each.

Nothing of the kind, however, existed in America, so it was essential that each Company should collect a coupon from each complete ticket; this gave rise to the band tickets previously referred to. Up to 1853 they were un-numbered; at

most a serial number showing the order in which the coupons were to be used was at times entered on them in writing. When the serial numbering had been appreciated, it was gradually extended to the detachable coupon tickets on which it first appeared in writing (figs. 461 to 464). The firm of *Sanford, Warren & Harroun* then entrusted George F. Hibberd with the construction of a press able to print bands of coupons, number them consecutively, cutting them from a continuous roll both laterally and longitudinally. The firm sank nearly 40,000 dollars before meeting with success.

In the meantime, George J. Hill, solved the problem with his consecutive numbering wheel which consisted in 5 to 6 discs mounted close alongside each other; each disc had the figures 0 to 9 engraved upon its periphery and returned automatically to 0 when the adjacent disc advanced one unit. As early as 1860, several Railway Companies ordered such machines.

We have seen above how the coupon system, easily checked and worked, has since developed ⁽¹⁾.

METHOD OF SEPARATING COUPONS. — For many years, Edmondson tickets had to be torn in two so as to separate the two portions when needful. Towards 1852, a line of small dots or strokes, coloured or not

(1) After the *Baltimore & Ohio R. R.*, the system was adopted by the *Chicago & North Western*, the *Illinois Central*, and other lines.

Warren retired in 1862 and sold his share to his partners. In that year the firm moved to New York but began badly, a fire destroying its premises. It succeeded in re-opening them with five new presses two months later. Annoyed at their success, Bailey, then still in Buffalo, tried to give as good as he got by infringing their rights. A lawsuit followed, with the sole result of putting money into the lawyers' pockets.

However, the partners had learnt their lesson and, seeing that they could not keep their monopoly intact, preferred to sell presses to other printers, including a licence to use them at \$ 8,000 each. In this manner, they supplied presses to the *Leisenring Printing House* (later *Allen, Lane & Scott*) of Philadelphia, to the *Montreal Printing & Publishing Co.* of Montreal, to *Wrightson & Co.*, of Memphis, and to the young firm of *Rand, McNally & Co.*, of Chicago.

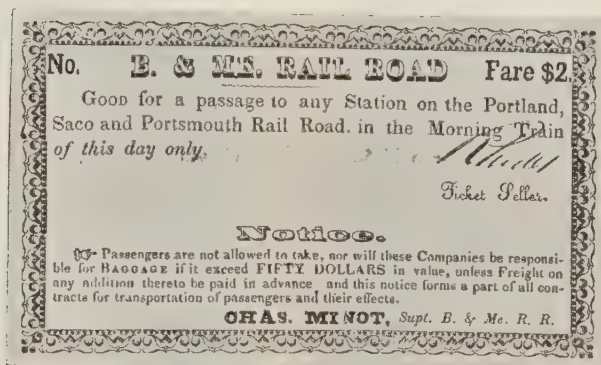


Fig. 462. — *Boston & Maine R. R.* ticket issued in 1853 — Without date or number.

At present paper tickets and leaflets are line-perforated so as to enable them to be separated from the checking coupons or to be detached on the journey. This perforation consists in a series of small holes, at times in saw-tooth or semi-circular openings. Since the introduction of automatic or semi-automatic machines, the perforation spaces serve the additional function of allowing the paper strip to be moved forward by levers or pawls engaging with them. Thus one meets with the most unexpected forms of perforation, both on reel tickets or zig-zag

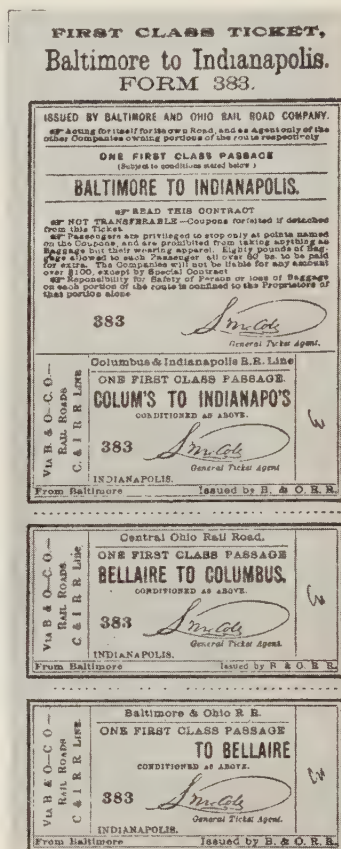
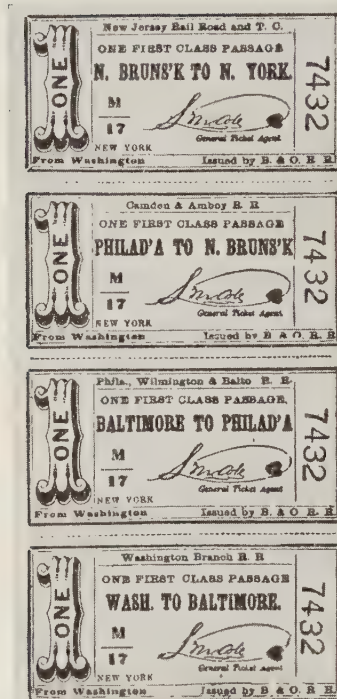


Fig. 463 and 464. — Old American inter-line paper coupon tickets issued by the *Baltimore & Ohio R. R.* about 1853, the first press-, the second hand-numbered (No. 3) — (Red. 3/4).

folded tickets, according to the machines (figs. 379, 414, fig. 563).

A design of some kind is often printed covering the perforation so as to show better where separation of the two portions must take place (fig. 47).

ADDING COUPONS TO TICKETS. — Coupons are occasionally added to tickets so as to complete them. In France, extra forms filled in on the train are usually affixed directly to the tickets (figs. 515 and 516).

In America, a validation strip is added

at the end of the band paper tickets after breaking the journey or when about to commence the return journey (fig. 514).

B. — IDENTIFYING THE TICKET WITH THE LINE.

Once the ticket has been issued and numbered, it must be identified with the journey. It is therefore arranged so as to serve its purpose between two places.

To facilitate checking, numbers are given

ven to the stations and zones and on road transport services, to lines and even to sections.

1. **Kind of transport used.** — The « International Convention » requires its members to print a vignette easy to recognise on tickets applying to journeys made by other means of transport than railways. These vignettes represent a boat (*fig. 90*), an anchor (*fig. 176*), or some other representative device. It often happens when the passenger may travel by rail or water, that vignettes for both means of transport, say a locomotive and a boat, are printed on the same ticket. This occurs on some of the *Verein's* coupons (*fig. 91*).

2. **Station numbers.** — To facilitate the collection of used tickets many railways print the number of the destination station on them (*figs. 456 to 458*) ⁽¹⁾. This number is repeated on each half of return tickets (*fig. 166*).

Uniform fare zone tickets only bear the number of the issuing station (*fig. 170*, *Paris Ceinture Ry.*). The small segment punched out of English children's tickets also bears this single number, so that it is easy to check that all segments belong to one and the same station; the name of the destination station and the class of ticket (category) are also shown on it. Some old Belgian Edmondson tickets, American coupons and underground tickets had the number of the destination station as well (*figs. 149, 152, 167*).

Though tickets have to be dealt with very rapidly at the exit of busy city stations, an accurate watch must be kept on them; the destination station number should therefore be as large as possible. This is why it is overprinted on them unrestricted by the text in which it would otherwise have to be inserted (*fig. 167*).

3. **Numbering routes and sections.** — The only railway tickets bearing the number of the line are the « combined » journey coupons (*figs. 91, 92*).

On zone fare Edmondson tickets the zone number is clearly shown, usually (*figs. 199 and 201*).

On road transport tickets, where it is frequently necessary to designate the route or service used on a straight or a transfer trip, numbering the routes saves considerable space. Either letters ⁽²⁾ or figures are used and sometimes the letters indicate the routes, and the figures the sections ⁽³⁾. A list of all the routes with their numbers often appears on all paper tickets, the numbers being duplicated on a key map of the system as well (*fig. 480d*).

The system adopted in Vienna is interesting because of the arrangement of the transport system which comprises radial routes (Nos. 21 to 80, printed at the top of the ticket), and circular routes marked Nos. 1 to 20 after the former, the names of suburban districts coming next with a space for the *Stadtbahn* to finish up. The radial routes have a maximum of 5 fare stages; two of them only (Nos.

(1) The French railways give to certain of their halts, the managing station number followed by « bis », and foreign stations, with a few exceptions (Brussels Midi, 110) the number « 0 ». The provisional stopping places or temporary halts, covered by the ticket in figure 185 (*Midland and Great Western Ry.*) evidently had none.

(2) In Paris the route letter was usually overprinted. The earlier transfer tickets were so marked (*figs. 188 and 765*).

(3) At Lille. — At Solingen, the number of each section of route is shown on the map of the system.

ALSACE ET LORRAINE, EST, ÉTAT (ensemble des réseaux), MIDI, NORD, PARIS A ORLÉANS, P.-L.-M., CEINTURES DE PARIS, ALGÉRIENS DE L'ÉTAT (ensemble des réseaux, y compris la ligne du tramway de Saint-Paul à Bédou, la ligne d'intérêt local de Tiarat à Tramelet et la ligne de Sétif à Tougourt et embranchement), P.L.M. (Réseau Algérien)

Père ou Mère de Famille Nombreuse
(§ 11 de l'Annexe aux Tarifs spéciaux command. C.T. nos 491 et 493)

CARTE D'IDENTITÉ N° M
valable jusqu'au 192

DONNANT DROIT TRENTE 0/0
à une réduction de
sur le prix des billets simples
ou d'aller et retour ordinaires

Délivrée à M.

PHOTOGRAPHIE
de 3 c/m sur 4 c/m
la hauteur de la tête
n'étant pas
inférieure à 2 c/m

SIGNATURE DU TITULAIRE :

A 192

SIGNATURE DU REPRÉSENTANT
DU RÉSEAU QUI DÉLIVRE LA CARTE :

**CETTE CARTE NE PEUT, EN AUCUN CAS, SERVIR DE BASE
DE CIRCULATION et doit être présentée à toute réquisition.**

OFFICE NATIONAL DES MUTILS ET RÉFORMÉS DE LA GUERRE.

CARTE D'INVALIDITÉ
N°

COMITE DÉPARTEMENTAL D

La présente carte est valable
du 192 au 192

Photo 3 x 4

POURCENTAGE D'INVALIDITÉ
50 0/0 OU PLUS
Réduction de tarif :
75 0/0

Nom, prénoms :
Adresse :
Profession :
Date et lieu de naissance :
A B
Le Titulaire, Le Représentant, Le Fonctionnaire.

EXTRAIT DU RÈGLEMENT

La carte d'identité est valable pour une année (1^{er} Janvier au 31 Décembre); elle doit être restituée sans délai si, dans le courant de l'année, le titulaire cesse d'être en activité de service.

Sur la présentation de cette carte, le titulaire obtiendra des billets au tarif militaire.

Le titulaire est tenu de l'exhiber à toute réquisition des agents des chemins de fer et de donner sa signature chaque fois qu'elle lui sera réclamée.

Sous peine de nullité, la carte ne peut être ratifiée, surchargée ou altérée d'une façon quelconque.

Toute carte trouvée en d'autres mains que celles de l'ayant droit est retirée et annulée, sans préjudice des poursuites judiciaires à exercer, tant contre le porteur que contre le titulaire, s'il y a lieu.

En cas de perte de sa carte, le titulaire doit en aviser immédiatement son supérieur hiérarchique, et directement le chef de la gare desservant sa résidence.

La carte égarée ne sera pas remplacée et le titulaire aura à se pourvoir, jusqu'à la fin de l'année, pour voyager au tarif militaire, d'une feuille de route ou d'une permission.

Le titulaire d'une carte perdue, qui n'a pas donné les avis ci-dessus, est responsable des conséquences de cette perte, au point de vue de l'usage frauduleux qui pourrait être fait de la carte égarée.

La carte d'identité n'est valable que si elle est revêtue des timbres secs du Ministère de la Guerre et des Chemins de fer, ainsi que des griffes et signatures requises.

IMP. HUGONIS, 6-1905

ARMÉE FRANÇAISE
OFFICIER
DE L'ARMÉE ACTIVE
Voyageant en Chemin de fer
sur les sept Grands Réseaux,
les Ceintures de Paris
et les lignes des Compagnies secondaires.

CARTE D'IDENTITÉ
Donnant droit au Tarif militaire
EXEMPTÉ DU DROIT DE TIMBRE
(Décision ministérielle du 10 Août 1897.)

1904

French identity cards allowing holder to obtain tickets at reduced prices. (Red. 3/4).
Fig. 465. — Father or mother of large family. Fig. 466. — War disabled men.
Fig. 467. — Officer on active service — Vignette: flags.

58 and 59) penetrate into the first zone at the centre of the City, within the « Ring Kai ». The circular routes have from 1 to 3 sections, some of which are subdivided in turn as Va, Vb, etc. ⁽¹⁾ (fig. 305).

So as to reduce the number of clippings certain particulars relating to direction of running and to time have been repeated. If a passenger travels from the centre to the outskirts of the city or if he uses the circular routes in a counter clock-wise direction, the zone number (at the top of the ticket, to the right of the fare value) is punched. If a transfer is made, the number of the week in the right outer column is punched one way, and for the reverse direction, the number in the left side one.

In Berlin, before the present system was introduced, a small number of different tickets was used, each of which, as in London, applied to a group of routes. On the front of the ticket there was a list of route numbers each with a double list of sections marked A to D, one for the outward trip, the other for the inward (fig. 221). Explanatory particulars appeared on the back, with the name of each route's fare section point.

The new tickets, 7 for the tramways and 6 for the buses, each bore a list of the 75 tram-route and of the 40 bus-route numbers, and of 32 fare stage numbers, the largest number existing on the longest route (fig. 210). To define a particular journey, the highest fare stage number to which the passenger was entitled to travel was punched and the ticket date-stamped.

English road transport tickets often bore a list of stage numbers for each direction. Where there are too many of them, some artifice is resorted to. Thus the *Southdown Co.* prints lists of the units and tens; a stage number is indicated by punching one figure in each list.

C. — IDENTIFYING THE PASSENGER.

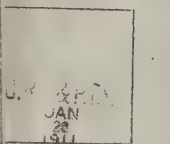
Having identified the ticket with the route concerned, it must be further identified with its holder as a passenger, before combining ticket and passenger and thus identifying the journey. This is done differently according to whether the ticket is to bearer — the most frequent case — or is personal.

Bearer tickets need checking, both as regards the tickets themselves and the journey they are issued for. Some classes of tickets are only issued to passengers who, when purchasing them, must prove that they fulfil the required conditions to do so. Such proof, essential for personal tickets, is even required in America for inter-line paper tickets. The passenger must therefore have some means of proving his identity; he must sign the ticket on request, and, in some cases, the ticket seller must add a more or less complete description of the holder.

1. **Identity cards** are issued to passengers either free or against payment, as the Continental half-fare cards and the American « Nickel Passes » (see chapter VIII, fig. 377). From the checking point of view, their existence or non-existence

(1) Lines 58 and 59 alone having a first section, their number is indicated in heavy type at the top of the ticket. The circular routes comprising one section only are similarly indicated immediately above those which are divided into several sections. The « Ring Kai » route being the most central one, only has two sections, known as R and K, which are also shown at the top of the ticket.

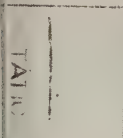
IF MADE ON RETURN TRIP AGENT
LAST POINT OF STOPOVER
WILL STAMP HERE.



WITH THE WITHIN CONTRACT
SIGNATURE MY NAME AS THE ORIGINAL PURCHASER.

A. Duim
Original Purchaser.
Russell
Ticket Agent.

ATION OR AT TERMINUS OF JOURNEY
WILL STAMP HERE.



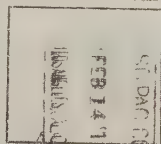
WITH THE WITHIN CONTRACT,
SIGNATURE MY NAME AS THE ORIGINAL PURCHASER.

A. Duim
Original Purchaser.
Russell
Ticket Agent.

VALIDATION

THIS TICKET WILL NOT BE GOOD FOR RETURN TRIP
UNLESS SIGNED BELOW BY ORIGINAL PURCHASER IN
THE PRESENCE OF AN AUTHORIZED VALIDATING AGENT
AND STAMPED BY SAME AGENT.

VALIDATING AGENT STAMP HERE



SIGNATURE *A. Duim* Original Purchaser.
(Use either left and face or back)

470 (a) and (b). — Validation on back
American band tickets. (Red, 1/2) —
date stamped by hand — Signatures of holder
and witnessing official.

trip tickets and free passes have to be
signed by the holder.

In the States, the holder must also sign
the inter-line band tickets in the presence
of witnesses and sign his name when
requested, the object being chiefly to prevent
his disposing of the non-used portion
or of the return half of the ticket
(fig. 15). As this applies especially to
home seekers and similar tickets whose
period of validity is very long (up to
nine months), a settler who had settled
along the route, might try to sell the portion
he no longer needs.

The validation forms have a similar
object. The rules prescribe that, after
payment has been made, an official shall
revalidate the ticket at certain points and
on completion of the outward journey,
and that he shall only do so when he is
convinced that the person presenting the
ticket is the original purchaser (fig. 470).

When the return portion of a strip is
to be rendered valid, or when certain
extra fares have to be paid, or else when
a journey is broken, an additional validating
slip is affixed to the ticket. Only
after this has been done may the passenger
use the ticket or even register his
luggage.

3. Description of the passenger is done
in two ways. In Europe and overseas,
some tickets, especially those available
for several journeys, have the photograph
of the holder, or holders in the case of
group journeys, affixed to them (fig.
471). In America, tickets bear a certain
number of descriptive personal details,
the appropriate ones being punched as
follows (fig. 15) :

Sex — male or female;

Build — stout, medium or thin;

Height — tall, medium or short;

Colour of hair — fair, dark or red;

Colour of eyes — grey, blue or brown;

Beard, moustache, whiskers (men only!).

D. — IDENTIFYING THE JOURNEY.

The ticket and the passenger having
each been duly identified, the journey itself
remains to be identified by combining
these two elements. The date and
time when the journey is undertaken and
the train to be taken must be stated. As
a journey may be modified en route by
stops and regular or accidental changes
of carriage the means of checking the
ticket accordingly must not be lost
sight of.

1. Identifying the direction. — So as

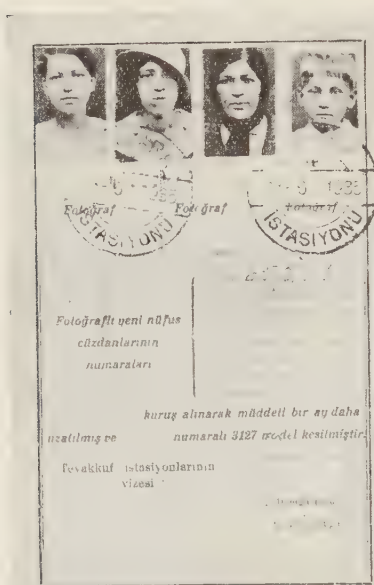


Fig. 471. — Collective ticket for members of a family. (Red. 3/4) — *Turkish State Rys.*
— Cancelled by post type date stamp.

to help its illiterate staff to check the direction of travel, the *Manchester and Leeds Ry.* used to print, on the backs of up and down tickets, about 1838, vignettes derived from the cotton industry. Tickets for Manchester bore a bale of cotton, those for Leeds a fleece, others a spindle.

Some railways used two distinct sets of colours for the various classes, one each way, return tickets combining the colours of the classes concerned in the order of travel ⁽¹⁾.

Booklet coupons for fixed destinations are available in either direction; those

from booklets of combined coupons bear the indication of the same journey both ways; the direction that is not travelled is cancelled (*fig. 92*).

British road transport tickets often give the fare stages for both directions (*figs. 174, 205*). Those with a single list had arrows to indicate the direction concerned, as do some of the Continental paper tickets (*figs. 351, 472 and 480c*).

The simple plan of cancelling a ticket for one direction in red pencil, for the other in blue, was formerly used and still is on some lines.

2. Dates and time. — A ticket is only available on one or more specified dates, and during a period which varies from several months, in the case of long return journeys, to one hour for platform tickets and even less for city transfers.

On stage coach and early railway tickets, these particulars were inserted in writing (*fig. 4*). They disappeared from the first English and American tickets, but Edmondson soon remedied the deficiency by inventing the date stamp which is still in use. At present, the « International Convention » prescribes that dating take place in a space 5 mm. (3/16") wide at the top and across the face of the ticket.

This date is usually dry-stamped (*fig. 452*), but ink stamping is used in England and America (*figs. 334 and 459*), either on the front or back of the ticket. Some Companies stamp ordinary tickets on the front and children's tickets, on the back.

When a single ticket is detachable for half-fare use, as in Belgium, each half

(1) This practice existed as late as 1873, on the *Great Western Ry.*, where 1st-class tickets, for example, were white one way and yellow the other.

On the *Great Eastern Ry.* tickets were respectively white, purple and green for one direction, yellow, blue and dark brown for the other. Unlike the practice of the other English lines, the left-hand half of the ticket was the return half.

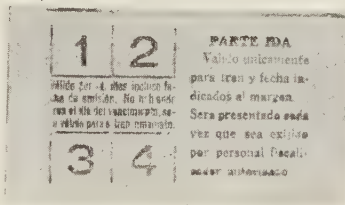
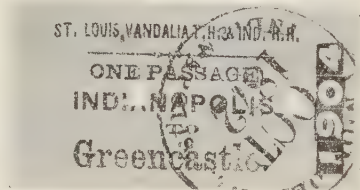
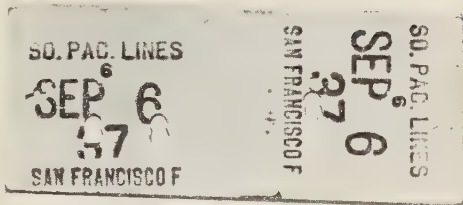
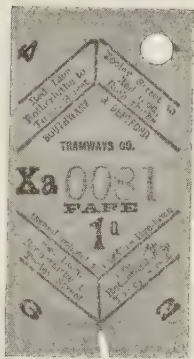
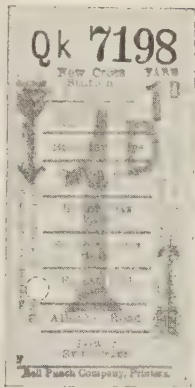


Fig. 472. — Old London ticket issued by *Thomas Tilling, Ltd.* (Red. 4/5) — Travelling up or down shown by arrows — Fare repeated in red overprint.

Fig. 473. — Old ticket of the *Southwark & Deptford Tramways Co.*, issued in 1882. (Red. 4/5) — Printing arranged diagonally — Fare stages shown by perforation or removal of corner.

must necessarily bear the number, which encroaches on the space usually reserved for the date. The latter is then printed on the back or in a lateral space reserved for it (*fig. 194*).

Indicating the date in perforated figures grants absolute protection against fraud. This is occasionally done with Edmondson tickets (*figs. 160 and 434*), always with coupon booklets (*figs. 91, 93, 447*).

The period of availability is always specified but not the final date. This is also the case with American Edmondson tickets which are stamped on the back — exceptionally on the front — with a stamp similar to that used on letters (*figs. 474 and 475*). On the other hand, paper tickets bear the final date of availability perforated through certain elements in pre-printed lists.

The YEAR is given first. Some lists bear the date 1900, followed by the complementary years for a given period. Others

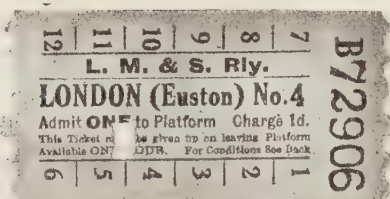
Fig. 474. — Departure station and date stamped on back — *Southern Pacific Lines.* (Red. 4/5).

Fig. 475. — Date stamped on front — Company's name in full. (Red. 4/5).

Fig. 476. — Date of return journey checked by punching in one of the printed spaces on the back, which correspond to period of availability — *Central Argentine Ry.* (Red. 4/5).

merely repeat the figures 0 to 9 twice. Two perforations are sufficient to indicate the year chosen from amongst those that have been listed or, when two lists of extra figures are given, any year of the century. On some European Edmondson tickets, only the year units are given.

The names of the MONTHS follow the year. Next, come the DAYS OF THE MONTH, treated like the years in a list from 1 to 31, or by the combination of two figures



1	2	3	4	5	6	7	8	9	10
24									11
23									12
22	21	20	19	18	17	16	15	14	13

Platform tickets. (Red. 4/5).

Fig. 477. — Tickets from reels *L. M. & S. Ry.* — Hours, 1 to 12, are indicated — Five-figure serial number.

Fig. 478. — *Gt. Western Ry.* cardboard ticket. With special mark overprinted.

Fig. 479. — Back of French *Nord Ry.* platform ticket — The hours from 1 to 24 are shown — The night hours are shaded.

taken from two lists, the tens one ranging from 1 to 3 and the units list from 0 to 9 (*fig. 103b*). A complete date is shown by three perforations if all the elements are listed, or by five if the figures have to be made up.

Each of the paper coupons in the booklets issued by certain urban lines also bears a large number indicating the day of the month (*fig. 30*).

On the Paris *Metropolitain*, and on other French lines, the day is indicated by its serial number in the year.

Two other factors, the WEEK and the

DAY appear on seasons and workmen's multi-trip tickets. They bear very clearly, often in overprint, the number of the week (*fig. 469*) besides a list of the days when they may be used, and often a double list, one for the outward, the other for the return trip (*fig. 335*).

The number of the week may also be punched out of a list. In Vienna, the list of the weeks only has 34 numbers beyond which the weeks are numbered again starting with number 1. This gives them a virtual number which does not correspond with the week's serial position in the year.

In addition to the first and final dates of the week of availability (*fig. 310*), American passes bear a distinguishing mark peculiar to each of the weeks (*fig. 344*). For some years past, coloured illustrations whose subject has been chosen from among the events of the week have been used (*figs. 309, 310*). Week-scale passes having a different symbol for each week have even been designed (*fig. 308*).

In certain large towns, where consumption of tickets is considerable, the date is actually preprinted. This occurs on the American multi-trip tickets (*figs. 310, 311*) as well as on London and Berlin ordinary tickets (*fig. 210*), and on American transfers (*figs. 247 and 298*).

But it is more usual to have lists of dates, months and days, and to designate the date of use (*figs. 192 and 214*). Listing the days of the week by name is exceptional.

TIME. — The printing on Edmondson tickets of the time as well as the date, scarcely needs referring to, save in connection with platform tickets available for a maximum period of two hours. Its beginning is usually shown by punching or snipping in a list of 12 or 24 hours

or of those hours during which the station is open (figs. 423 and 477). Sometimes the night hour figures are shaded (fig. 479) (1).

Exact indication of the time has the same importance in road transport, where workmen's tickets are available during certain hours only and transfers must be used in the first car which comes along. These tickets bear the hours of the day or those only during which the services are run (fig. 103b); in America, the remaining part of the night, called the owl period, is reckoned as a single hour.

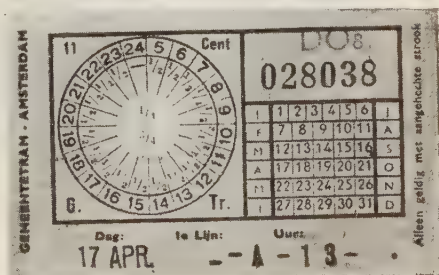
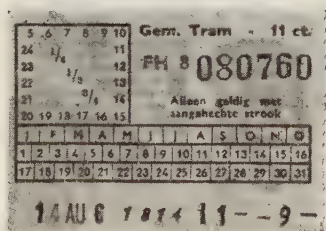
The indication of the hour is completed by the minutes at intervals of 30, 20, 15, 10, and even 5 (as at Magdeburg). Normally two punchings would be required for the hours and minutes respectively, but one suffices when the list of fractions of the hour is repeated opposite each hour or each group of hours (figs. 190 and 248).

The list of hours can also be shortened

to 12. The presence or absence of a detachable P. M. coupon shows if evening or morning hours are meant. The list of minute fractions may also be printed twice, in ordinary type for morning, in negative type for evening hours; a single punching is then sufficient to indicate the time (figs. 191, 247).

GRAPHICAL INDICATION OF THE TIME is frequently met with, especially in Europe. Much space is saved by using a dial for this purpose (figs. 480 and 481), and if the service is suspended during part of the time, it is unnecessary to list the hours when no cars are run. Concentric outer rings may indicate the half hours; even the quarters and three quarters can be so designated, but the circles then becoming too small, these fractions are generally inscribed once only in the middle.

The 24-hour dial can be halved in various ways: by using two sets of tickets; by using two dials of 12 hours each; by marking the morning and evening hours

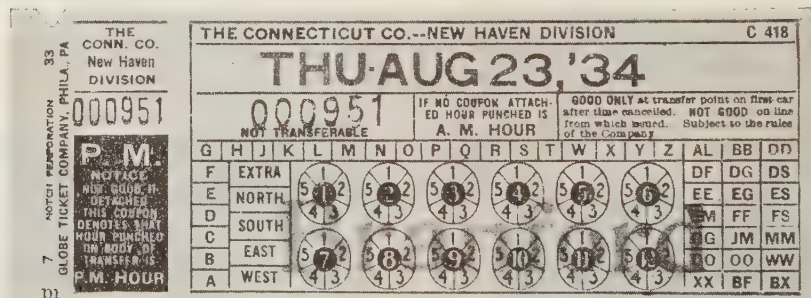
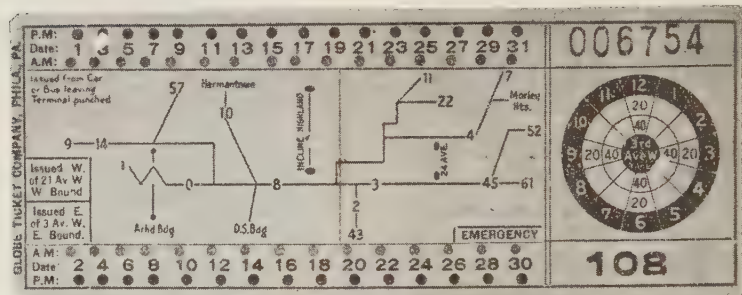
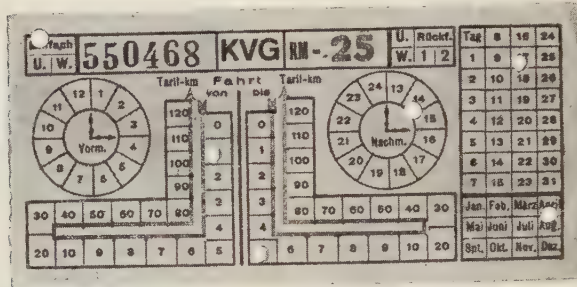


Tickets with dials for indicating the time. (Red. 3/4).

Fig. 480a. — *Utrecht Municipal Tramways* — Rectangular dial, with quarters of an hour marked inside.

Fig. 480b. — *Amsterdam Municipal Tramways* — Double dial, the outer one showing the hours from 5 to 24, the inner one giving half hours.

(1) There are small variations in these arrangements. Even hours only are listed on German tickets. On certain English ones, the hours are grouped from 1 to 4, 5 to 8, 9 to 10, and 11-12. The figures appear sometimes on the front, sometimes on the back.



Tickets with dials for indicating the time (*Cont'd.*). (Red. 3/4).

Fig. 480c. — *Kraft Verkehrs Gesellschaft* — Two dials — Directional arrows — Lists of kilometric fares and categories.

Fig. 480d. — Three-circle dial for 12 hours, for 20 and for 40 minutes — Map with route service numbers — A. M. and P. M. indications for each day of the month.

Fig. 481. — *Connecticut Co., New Haven* — A dial with 10-minute divisions for each hour out of 12 — Extra P. M. coupon — List of routes.

concentrically or only printing 12 hours and cancelling the figure concerned by punching above or below for a. m. or p. m., or more simply still, by using a

p.m. coupon. Multiple dials are used for workmen's tickets.

DATING STAMPS allow of smaller tickets

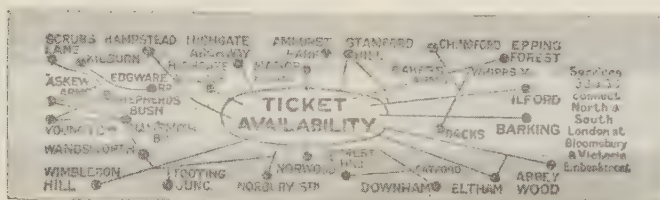
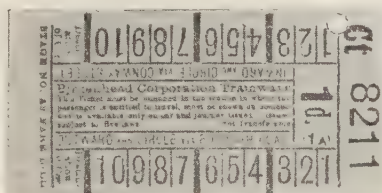
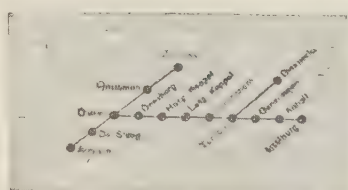


Fig. 482. — Back of ticket with diagrammatic plan of the system — *Geldersche Steam Trys. Co.* (Red. 4/5).

Fig. 483. — Fare stages grouped to facilitate checking — *Birkenhead Corporation Tramways*.

Fig. 484. — Back of all-day ticket, *London County Council Tramways* — Diagram showing ticket availability.

without preprinted dates or hours being used; a simple stamping then dates them accurately (*fig. 350*, *figs. 486* and *487*); besides this they are time-saving (about 30 %).

The date stamps used at Nuremberg since 1929 ⁽¹⁾ include two lines of text, the first comprising a groove to carry the rubber type quotes the day, the month, the conductor's number, and prints a star; the second adds the hour, 0 to 24, and half hour.

The end of the trip the passenger is entitled to accomplish is shown by a massive « V » rubber type at the end of the stamp. The ticket board holds an easily replaceable inking pad. There are two protecting plates above and below; they prevent the conductor's dirtying his fingers when replacing the rubber type bands, which last six months.

The impression of the date (day, month and year) above the hour (and half hour) is made on a special part of the ticket, and the « V » showing the end of the trip appears where required.

For combined tram and bus journeys, the conductor issues, in addition to the transfer ticket on which the bus system map and list of supplementary fares are shown, a small value-ticket, at a fare proportionate to the journey. He dates both tickets and marks with a « V » the fare of the supplementary ticket to be issued, and the terminal.

Weekly season tickets are similarly stamped both on the outward and return journeys, the time being shown by a «V» for the former, and an inverted «V» for the latter.

Transfers are cancelled in the second car either by tearing, as at Nuremberg, by further date-stamping, as at Lyons (fig. 487), or again by punching, as at the Hague.

(1) Certain of these particulars are taken from a paper by Herr Georg Schroedl, chief inspector, *Nuremberg and Fürth Tramways*.

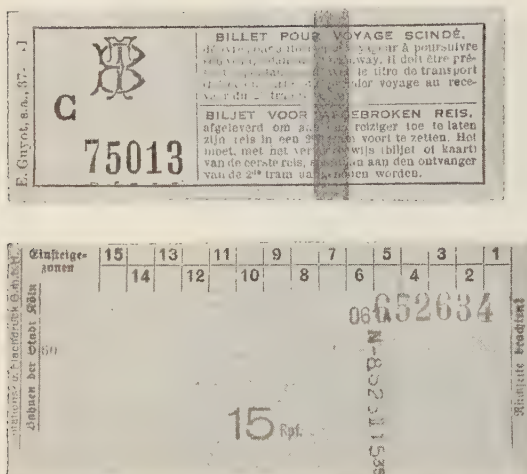


Fig. 485. — Bilingual ticket for broken journey. (Red. 3/4) — Monogram of Brussels Tramway Co.

Fig. 486. — Ticket for use with date stamp. (Red. 3/4) — Cologne City Tramways — List of fare stages.

Fig. 487. — Transfer ticket of fixed value for use with date stamp — Lyons motor-buses. (Red. 3/4).

OTHER DATES APPEARING ON TICKETS.

Excursion or special-train tickets generally bear the date on which the journey must be made.

To facilitate the checking of stocks, most paper tickets, books of coupons, sheets or combinable coupons, also bear the millesim indicating the year and often the month of printing (figs. 91 and 485). Millesims are scarce on Edmondson tickets, less so on urban and light-railway paper tickets (fig. 21).

Some paper, and even Edmondson tickets, give the time schedules of special trains, but the times of regular services are only shown exceptionally; they are given occasionally on cross country motorbus tickets.

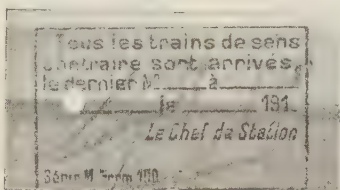
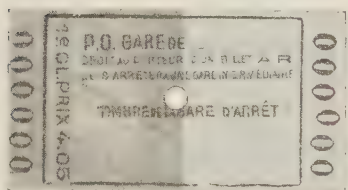
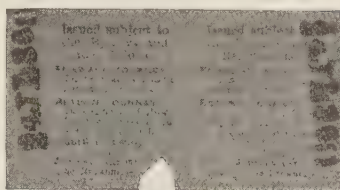
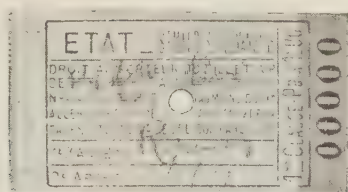
3. Train numbers. — Except for the express and « de luxe » train supplements, tickets do not show the numbers of the regular trains, but those of excursion or special trains are often printed on them. The *Cork, Bandon and South Coast Ry.* used a special date stamp which printed the train number in front of that of the month.

On the other hand, many light-railway paper tickets, especially returns, often have a list of train numbers in which the conductor marks the proper one (figs. 192 and 222).

Whilst there is no need to show the numbers of the ordinary trains, it is important when many special ones are running to classify passengers into the right trains. They are often marked with a clearly visible sign or number which is reproduced on the tickets (figs. 494 to 497).

On race days or other special occasions when passengers take any train that happens to come along, it is indispensable that ticket collectors should be able to recognise special tickets at a glance. For this purpose, the French *State* and *P. O. Rys.* overprint Edmondson tickets with special signs such as a star (fig. 623), a coloured circle, oblique or crossed lines. The *Nord* prints tickets in two shades of the same colour, the special sign (jockey's cap, locomotive, etc.) appearing light on a dark ground on the outward half, and the reverse on the return one (figs. 498 and 499).

The same principle applies in road transport. The *Barcelona Steam Tram-*



Edmondson tickets. (Red. 4/5).

Figs. 488 and 489. — Stop-over tickets, French State and P. O. Rys., allowing break of journey.

Fgi. 490. — Back of New South Wales Government Rys. return ticket with text arranged to allow space for clipping.

Fig. 491. — Ticket certifying arrival time of trains from opposite direction.

ways ran a whole set of signs which were not only used for checking purposes, but for others as well.

4. Broken journeys. — When a trip commenced in one city car has to be continued in another, the first conductor gives the passenger a special transfer ticket, known in Brussels as a « broken journey ticket », and as a delay check in America, and this is honoured in the second car (figs. 485 and 382).

Breaking a railway journey is sometimes liable to certain conditions. The passenger is frequently required to have his ticket stamped on arriving at and on leaving the station. In the case of booklet coupons and sometimes of ordinary Edmondson or other tickets, one of the spaces corresponding to the stopping points has to be punched (fig. 91). On certain Canadian and Italian tickets, this clipping takes place through one of the elements of lists of hundreds of miles or

kilometres, with which the tickets are provided. In Australia the tickets are retained during these breaks of journeys, by the station master. Some Railways issue, generally free, special Edmondson « stop-over tickets » (figs. 488 and 489).

5. Countermarks and exchange tickets. — The principle of the system consists in leaving the ticket proper with the railway official for checking purposes and issuing to the passenger another one which is, in effect, a more or less detailed receipt, for the ticket itself. This is done in various ways.

In America where exits from stations are free and open, the ticket is collected on the train, but in return, the passenger gets a token to justify the rights he has acquired; this is a countermark which is taken from him on completion of the journey (figs. 285, 286).

Countermarks are given elsewhere, for accounting and statistical purposes, in



Figs. 498 and 499. — Nord Railway (France) return tickets bearing signs so as to distinguish tickets issued for special occasions from the usual ones — Printed in two complementary colours, whose order is reversed on the two halves. (Red. 4/5).

After reminding the passenger that

Honesty is the best policy.

the *London General Omnibus Co.* used to request him to watch that the conductor issued the tickets correctly (fig. 553). He is still requested to see that his ticket is properly punched. The American Companies generally add the word « please ».

So as to check the sales, Companies often repurchase their used tickets. A small refund is awarded for them in the United States; in Central and South America, a lottery ticket is offered in exchange or a small percentage of the face value is paid, in the name of the person tendering the tickets, to some charitable institution [see page 705 (169) and figs. 272, 384 and 385].

2. **Checking the passenger.** — The holder of a ticket is subject to certain obligations: he must show it when requested or give it up on demand.

Some Tramway Companies require him

Light-railway paper tickets with illustrations for checking purposes. (Red. 3/4).

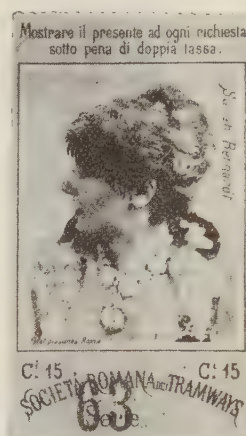
Fig. 494 and 495. — *Barcelona Steam Tramways* tickets with vertical detachable coupons.

Fig. 496. — Coupon from season booklet — *Asturian Coast Steam Tramways Co.*

Fig. 497. — Coupon from season booklet — *Barcelona Steam Tramways.*

his interest or amusing him (figs. 554 and 557), so as to get him to insist that the conductor should hand him the ticket he had paid for.

In this way it was hoped to induce him to secure the ticket for its own sake, the right to travel with it being thrown in as a sort of extra, and that in this way receipts would be increased! This caused the appearance, round about 1875, of collections of illustrated tickets to which we shall refer again (figs. 500 to 504).



Old chromo-lithographed tickets, with portraits of celebrities, issued towards 1880.
(Red. 4/5).

Fig. 500. — *Barcelona Tramways Co. Ltd.*

Fig. 501. — *Rome Tramways Co.*



Figs. 502 and 503. — Old tickets of two Barcelona Companies, illustrating the adventures of Don Quixote — Chromo lithographed about 1875. (Red. 4/5).

to destroy it on leaving the vehicle; one wonders how, as he is prohibited from throwing it away in the street!

Finally, certain American Companies

which issue transfers up to 8 inches long show a sense of humour by printing the word: *Do not fold* :

« Do not fold »



Fig. 504. — Old lithographed illustrated tickets. (Red. 4/5) — *Oliva Omnibus Co.* Madrid, issued about 1875.

or :

« Not good if folded or crumpled » (1).

In addition to regulations made by the railways, passengers must conform to others made by the various Governments. Extra leaflets giving particulars, some of which concern passport and customs formalities, others stating they have been issued in conjunction with the ticket bearing such and such a number, and so on, are therefore inserted in the books of « combined coupons ».

When special reductions are granted on transit journeys or to passengers staying a minimum time in a country, a special duly dated leaflet is inserted to this effect (fig. 506).

3. Checking of used tickets. — In order to see whether all Edmondson tickets issued have been returned, and particularly that no forgeries have come in, the made-up packets are marked before being sent to the stations, with a loose design of crossed diagonals or other continuous lines. Any irregularity in the design after the packet has been made up again is

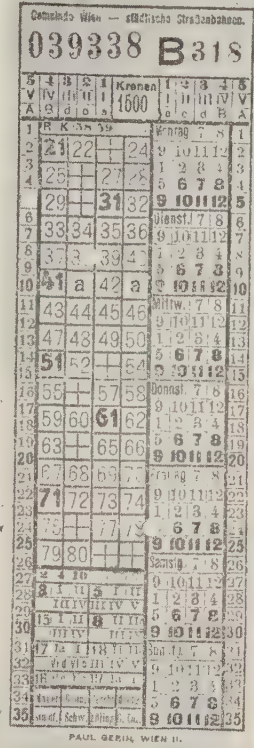


Fig. 505. — Ticket issued by the *Vienna Municipal Tramways* during the inflation. (Red. 3/4) — Value, 1500 crowns — Routes, fare stages, hours and days shown. Direction indicated by the side on which the ticket is punched.

easily detected and shows that a ticket is missing or that a fraudulent one has been included.

Weighing tickets. — We showed on pages 669 (133) et seq. how the tariffs in American city transport are made to follow the number of passengers carried of each class (category). This is only possible when tickets and transfers collected

(1) *British Columbia Electric Ry. Co. Ltd.; Butte Electric Ry. Co.*

The number of tickets or transfers per pound is multiplied by 2, 3, 4 and so on, up to 15, in order to facilitate rapid work, and these counts are tabulated. This is done daily in order to offset atmospheric changes which effect the weight of the paper. Having obtained the units, the bulk of the tickets and transfers is then weighed by lines, the volume by unit weight noted and, being translated into weight, is set down as the number collected by the given line for the day. From time to time, the accuracy of the figure obtained is checked by counting.

SECOND METHOD (fig. 508). — This gives greater accuracy and is based on weighing to ounces. The number of tickets per ounce is taken to be the average of the numbers contained in batches coming from six different routes. If needed some tickets are sometimes halved in order to obtain an exact balance. When the six have been weighed out, they are counted, added up and divided by six to get the average count per ounce.

A unit scale is then established for each number of tickets, ranging from 130 to 180 tickets to the ounce. The scale starting with one ounce runs up by ounces to 16. It also descends by tenths of an ounce to $1/10$. The scale bar on which the balance weight slides is graduated in tenths of an ounce.

The tickets are now weighed one line at a time and the weight at once translated into count from the scale. Remainders less than $1/10$ ounce in weight (13 to 18 tickets) would be counted by hand. The scales are tested weekly by actual counts so that any departure from exact balances may be noted and corrected.

Although the weight of paper may vary much as by 33 p. c., this method eliminates this source of error; the ap-

proximation obtained is less than two tickets per ounce.

THIRD METHOD (fig. 509). — In this case the tickets are not weighed in the sense of commonly accepted units of pounds, etc. They are counted by a proportion scale.

There are the usual weight beams with sliding weights of fixed value, so that the scale can be formed in the ordinary manner if desired. There is also another weight beam known as the Counting Bar. This has four faces, anyone of which can be faced to the front if desired, each face

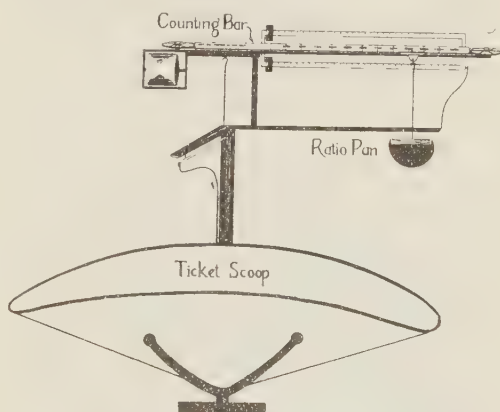


Fig. 509. — Checking scale for weighing transfers — Third method.

being graduated from 0 to 2,000. At the left end of the bar is certain information relative to the number of tickets to be used as the basic unit when reading from the given scale. This unit varies, of course, from face to face but runs in multiples of the first one.

The Ratio Pan takes the place of the sliding fixed weight. Into this pan the required number of tickets is counted — 8, 16, 40 or 80 as the case may be — and the pan is moved on to the 2,000 mark. The tickets are placed in the scoop until the scale is in exact balance. At this

point there will be exactly 2,000 tickets in the scoop. When the remaining tickets will not balance the scale at 2,000, the pan is slid back on the bar until the scale is again in balance, and the exact count of tickets in the scoop is read directly from the graduation on the bar.

Obviously when a large quantity is being counted, the procedure may be speeded up by placing a multiple of the required number in the pan. Thus, when using the 80 face, if 160 tickets are counted into the pan, the remainder in the scoop at balance will be 4,000 instead of 2,000. The limit of speed in counting is the limit of the capacity of the scoop to hold tickets in bulk.

To eliminate incidental sources of error the following precautions are taken :

(a) The count of tickets for the Ratio Pan is taken from the tickets for the particular line which is being counted.

(b) When that line is complete and recorded the unit count is discarded and another taken from the next line. A difference in weight might arise from variation in the conditions under which tickets are stored at the different depots, and this is a means of nullifying it. The deposits with which tickets become coated will not affect the results; this is covered by the way batches of tickets for the Ratio Pan have been selected.

CHAPTER XIII.

CANCELLATION OF TICKETS.

There are two stages in the cancellation of tickets. The first prevents a ticket being unduly used again. At the same time indirect cancellation frequently takes place and occurs when marking the elements of the journey in progress, thus

preventing those of some other journey being imprinted later on the same ticket. The second stage takes place after a journey is finished and involves the destruction of the ticket, which is outside our subject.

A ticket may be cancelled by mutilating it, by tearing, perforating or nipping it, or by overprinting.

1. Removal of the corner is used chiefly for tram and bus paper tickets, when issued; this prevents later use. On transfers, the particulars of the journey are merely marked by the first conductor, and it is the second one who removes a corner of the ticket and thus invalidates it.

The same method has sometimes been used for multi-trip cards, a corner being removed for each of the first four journeys, and the main part of the ticket being torn for the fifth and last.

2. Perforation affords a sure means of preventing a ticket being used for any other than the intended purpose. It is also an indirect means of cancelling the



Fig. 510. — Various shape clippings of road tickets identifying the conductor (Red. 4/5)

ticket, as it identifies it with a particular journey; the punching actually prevents the ticket being used for any other.

A ticket is punched for one of several reasons :

(a) Identifying the ticket. — Sometimes the ticket number, or some other checking number is perforated through it.

(b) Avoiding forgery. — Many Companies, especially city transport, punch out their initials or some conventional sign (*fig. 184*).

(c) Modifying certain items. — This happens principally in connection with changes of fare. The Paris transport and a number of other undertakings indicate small increases of fare by this means (+ so much) or, in the case of larger ones, the new face value is perforated through the ticket (*figs. 620 and 621*).

Conventional signs sometimes take the place of numbers. In Brussels, the removal of the corner of the ticket in a machine showed that its value had been altered ⁽¹⁾; in other cases a star is punched out ⁽²⁾.

(d) Identifying the journey. — Perforation of the date is seldom used for Edmondson railway tickets (*figs. 160 and 434*), but is frequent for booklets of coupons and of « combinable » tickets (*fig. 93 and fig. 447*). In *Mexico* this is used for tramway paper tickets as well.

(e) Cancelling a journey. — To prevent an Edmondson ticket being used again unduly, a piece of the ticket is snipped out; a series of such pieces may be removed in turn, especially with multi-trip tickets (*fig. 348 and fig. 530*) or the American band tickets (*fig. 514*). On the latter, as on Italian Edmondson tickets, special spaces are provided for the purpose.

(1) *Brussels Tramways Co.*

(2) *Belgian National Light Rys. Co.*

By varying the shape of the segments clipped out (a star, a letter, a half moon) a road vehicle conductor (*fig. 349 and fig. 510*), or a railway ticket examiner or collector, can be identified (*fig. 337*). Even when all clippings are alike, when the pieces come from tickets differing in colour according to class or value and are retained in the punching apparatus, they can serve for statistical purposes.

The BELL PUNCH AND TICKET SYSTEM, which uses a recording perforator with a bell, is still by far the most widely used all over the world, in spite of its more than sixty years existence (*figs. 511 and*

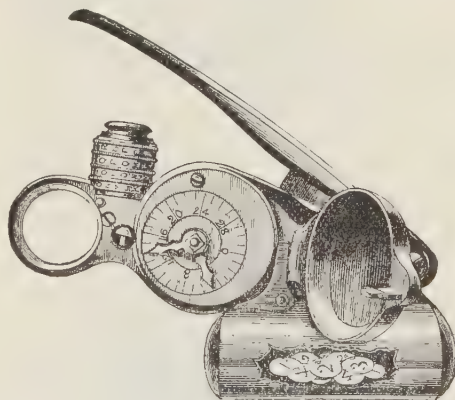


Fig. 511. — Original recording and checking apparatus of the *Bell Punch Co.*, as used in 1880.

512). The *Bell Punch Co.* was founded in 1878 with the object of instituting a safe and efficient system of working for road transport concerns. It is remarkable that so old a system should have been able to last so long without any alteration worth mentioning. By the arrangement of interlocking checks the quantity of tickets in issue is never in doubt, this furnishing accurate statistical information concerning the traffic.

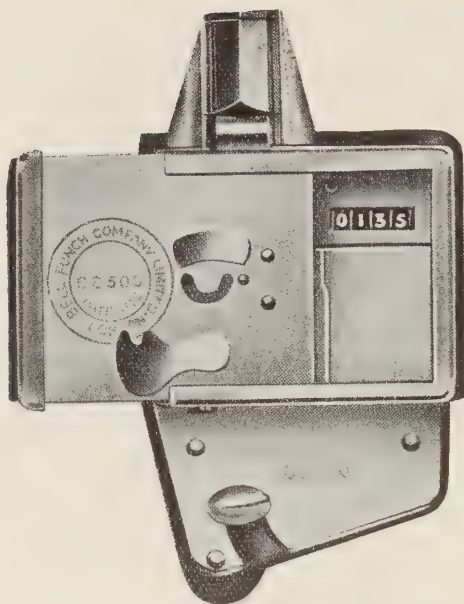


Fig. 512. — *Bell Punch* modern recording apparatus.



Fig. 513. — Checking and recording apparatus for workmen's weekly card tickets — C. A. M. P. System.

The system is based on fares varying with the distance travelled, the passenger buying the amount of transport he desires and being then free to use it. Each route is therefore divided into stages, a list of which appears on the tickets (*figs. 206 and 225, fig. 472*). The latter are of fixed values, with a different colour for each, the passenger being thus able to tell at a glance if he has received the correct denomination of ticket called for by his fare.

The only mechanical feature is the recording alarm punch, which sounds a bell each time a ticket is punched and retains a circular (3/16") diam. clipping of the ticket in an inaccessible container (*fig. 174*).

The number of tickets of each value issued is arrived at in two ways, one acting as a check on the other. The number of tickets sold is the difference between the numbers of those issued to the conductor and the lowest number of those remaining with him. These figures are compared with the entries on the way-bills, to see if they agree. Should there be any divergence in these records, the matter is finally settled by counting the clippings of the colour in question, for they are irrefutable evidence of each punching operation. London tramways and many foreign Companies were quick to see the advantages of the system, buses were slow to adopt tickets at all. Curiously enough, whereas an Inspector might oblige a tramway passenger to show his ticket, he was powerless to get an omnibus patron to do so.

The first London omnibus tickets were those of the *Metropolitan Ry.*'s buses ⁽¹⁾

(1) These were originally exchange tickets delivered to holders of through rail and bus tickets, but after a time other passengers were allowed to occupy vacant seats and tickets were sold to them.

READ THE CONTRACT.

ISSUED BY
UNION PACIFIC SYSTEM

Non-Transferable Ticket
Sold Subject to tariff regulations
When officially stamped
GOOD FOR ONE
SECOND CLASS PASSAGE
to destination shown herein which
must be reached not later than mid-
night of date punched in margin.

IMPORTANT
This ticket will be good for passage in
Coaches and Chair Cars only. Not good
for passage in Standard or Tourist Sleeping
Cars or Parlor Cars.

Baggage arrangements and charges are as
shown in tariff under which this ticket is
sold.

In selling this ticket and checking bag-
gage hereon, the selling carrier acts only
as agent and is not responsible beyond its
own line, except as such responsibility may be
imposed by law with respect to baggage.

(Signature of Original Purchaser)

Form S. C. C. 1
J. H. Basinger
Passenger Traffic Manager.

GUM

6
UNION PACIFIC SYSTEM
SECOND CLASS EXCURSION TICKET
GOOD ONLY IN COACHES
First Person
Via Mo. Va. R.R.
From Pueblo Colo.
To New Orleans La.
Form S. C. C. 5 Not Good if Detached
Via New Orleans La.
CONDUCTOR'S PUNCH HERE
1 2 3 4 5 6 7 8 9 10

Fig. 514. — American band ticket, Union Pacific System. (Red. 3/4).

Upper portion is a validation strip gummed onto the coupon, with date indicated by three perforations.

Three signatures or facsimiles — Advice to passenger : « Read your contract » — Coat of arms in negative type.

Lower portion : Blank coupon — Spaces for 10 conductor's punchings — Luggage and half fare shown by punching.

(fig. 766). The London Road Car Co. which succeeded to the London and District Omnibus Co. in 1883 seems to have used them from its inception where-as the London General only adopted them in 1891. These were all reel paper tickets so as to prevent irregular issue. But the conductor's perquisites had been on such a scale that no sooner had the General announced its decision to bring in tickets than the staff opposed it and a week later, went on strike. However this was broken within a week.

The « Bell Punch system » was introduced in 1893. Ten years later, the weight of a year's tickets ran well over 750 tons.

Experience shows that soft cardboard is best for the tickets. Their original dimensions of 1 3/8" by 2 3/8" (fig. 175) have been reduced and standardised to a width of one inch, the length varying with the number of fare stages.

Larger sizes are to be met with in Holland (fig. 220).

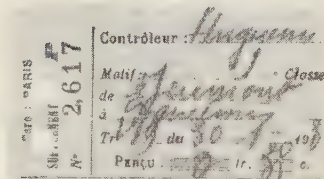
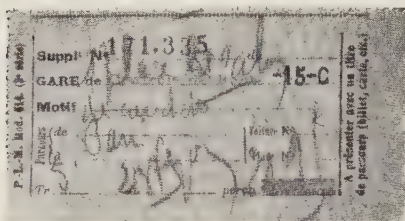
The C. A. M. P. workmen's cards cancellor can punch, when required, three perforations one above the other. The top one, a half circle, indicates that the car is travelling in the down or outward direction; the lowest, lozenge shaped, is used on morning trips. The absence of one or other of these perforations has an opposite meaning.

The centre punch indicates the day. 22 shapes are available for it and it is changed daily with a key.

After inserting the card in the cancellor (fig. 513), the handle is depressed until the bell rings, when the pieces punched out will have fallen into the removable receptacle and the card may be withdrawn. A safety device compels the handle to be moved the full stroke.

PERFORATION OF AMERICAN TICKETS COM-

plies with certain general rules. When one of two existing elements must be indicated, the lesser of them alone is punched. If no perforation appears, then the higher item applies. In other words, punching must reduce the value of the



Figs. 515 and 516. — Blank paper tickets issued in the train, and gummied onto original tickets held by passenger (Red. 4/5) — French P. L. M. and Nord Railways.

ticket, otherwise it would be easy to increase it by fraudulent punching. This procedure is applied :

To the two classes of passenger accommodation;

To full or half-rate fares;

To the conveyance or non-conveyance of luggage;

To possible refunds (fig. 226).

In lists of more than two elements, the first is not shown; absence of perforation indicates that none of the other elements (those that are shown) applies to the journey. If any other than the element which is not listed is punched, that element rules the ticket. This method is used to indicate :

The number of passengers in a group;

The number of days of availability of excursion tickets, etc.

When numbers of some size have to be indicated, the units, tens, hundreds, and even thousands, are printed separately in lists or rows of 0 to 9 and the punching of a figure from each of the four series will form any number from 0 to 9,999 :

Train;
Fare stages;
Reserved seat numbers;
Dates

are shown in this way (figs. 492 and 493).

In American practice, the various punchings combine. Thus, to identify a particular journey, all that is required is to punch in this manner the units, tens, hundreds and thousands, showing :

Seat number (units and tens);

Train number (units, tens and hundreds);

Fare received for passengers and luggage (dollars, dimes and cents);

Number of excursionists;

Period of availability (1).

Punching the seat number ipso facto acknowledges the payment of extra seat-fare.

3. Clipping. — INDIRECT CANCELLATION OF TICKETS. — Instead of punching Edmondson tickets they are sometimes nipped along the edges (figs. 441 and 443). This is also done in the spaces multi-trip or other tickets may be provided with. Figures 346 to 350 show the different methods of indirect cancellation : nipping, perforating, removing a corner and ink-stamping. Figure 323 shows soft cardboard tickets and figure 325, Edmondson tickets.

The English railways use the same process to cancel their tickets definitely and render them worthless, after having passed them through the auditing de-

(1) Michigan Central Ry.

partment. Quite a decent sized piece is hacked out (fig. 478).

NIPPING PAPER TICKETS selects particulars out of a list, and is applied, in America, to the so-called « stromberged » duplex tickets (fig. 253).

Transfer cutters (figs. 245 to 252) sever them across and, at the same time, thanks to the sliding indices, nip the body of the ticket in one or more places, so marking the desired particulars concerning the journey. Similar cutters are or have been used in Frankfurt and a few other European cities.

At Hälsingborg, a slightly different method is applied (fig. 517). The tickets are slipped perpendicularly into the apparatus. The cutting indices can be advanced so as to cut the particulars marked in two or three rows along the lower edge of the tickets, to the desired depth. The time is thus shown to the nearest half hour.

OTHER EDGE NIPPING. — The centre portion of the long edges of Edmondson tickets is nipped out when issuing them at half fare. The shape of the segments varies with the Companies (figs. 457 and 459).

A circular shaped segment is cut out of insurance tickets to distinguish them from transport ones (fig. 422), and also out of the hollow tickets containing publicity matter, so that the latter may be withdrawn easily (fig. 558). The semi-circles cut in opposite faces of the short edges of the « Automaticket » strip tickets are essential to their proper handling (fig. 380).

4. Indirect cancellation by ink-stamping. — This is used with partially pre-printed tickets. Items relating to a defi-

nite journey and those necessary for checking purposes are printed on issuance by special appliances.

These ticket machines are generally carried on a shoulder strap but are occasionally fixed to the car in a handy position, especially in one-man vehicles. They must therefore be light and compact.

Also the text they print must be rapidly set up and appraised by the conductor at a glance. The apparatus must be easy to handle and the recording mechanism, inaccessible to the conductor.

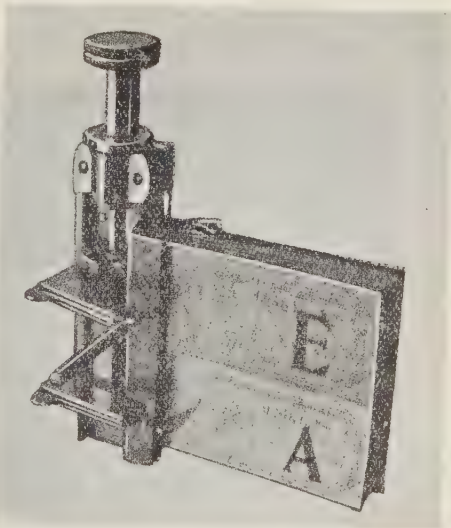


Fig. 517. — Hälsingborg Tramways cutter.

Several machines meet these requirements, particularly the « Controlex » the « Setright » and the *C. A. M. P.*

The « Controlex » machine is manufactured by the *Numerus Company* and issues tickets from reels (fig. 519). It uses pre-printed fixed-fare tickets which

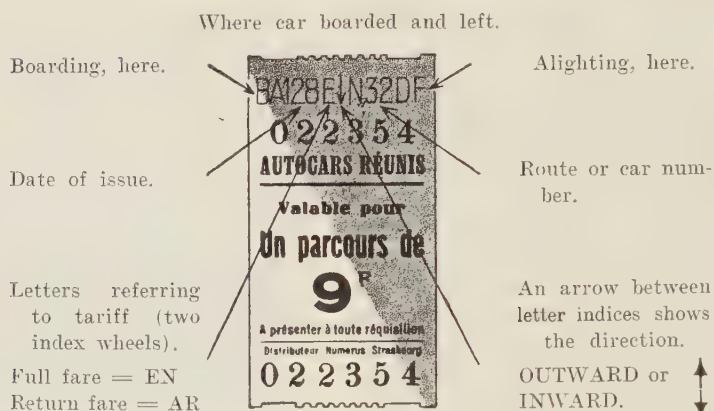


Fig. 518. — Preprinted ticket with data referring to particular journey, added by « Controlex » machine made by the Numerus Co. — Special perforation.



Fig. 519. — Numerus Co.'s « Controlex » 18-way apparatus.

it associates with the trip for which it delivers them, by means of a « fare-canceller » which prints in their upper part a series of particulars as shown in figure

518. Adjustable index wheels enable the variable elements to be set as required; they are all printed at once ⁽¹⁾.

These appliances are 40 cm. (15 3/4")

(1) The 5-button cancellor contains 10 wheels, 5 being fixed and 5 adjustable from outside handles, the fixed ones being worked by a small plunger after the group has been released from the frame of the cancellor.

long and 10 cm. (3 15/16") deep. The 18-cell portable instrument weighs 3 kgr. (6.6 lb.) and is 18 cm. (7") high, whereas the fixed 28-cell type weighs 4 kgr. (8.8 lb.) and is 27 cm. (10 1/2") high. As all tickets are 30 mm. (1 3/16") wide, the number contained in each cell varies with their length only. There are 250 tickets of 40 or 60 mm. (1 9/16" or 2 3/8"), 200 of 85 mm. (3 3/8"), or 125 of 115 mm. (4 33/64"). By using a combination of four-value scale tickets, it is possible to issue up to 100 different tickets (fig. 414).

The « Setright » punching and recording machine (fig. 520) issues serially

numbered thin card tickets (1 1/4" by 2 1/2" or 3 1/8") on which are printed the Company's name, the class of ticket, and at each end a red grid on which the particulars of the journey and the direction of travel are to appear (figs. 521 to 523).

For statistical purposes different card is frequently used for single journeys, for return, and for workmen's tickets.

The machine prints and records 143 values, and deals with fares from 1 penny to 11 sh. 11 d. in 1-d. values. Tickets pre-printed « 1/2 d. » in red are used for fractional values.

INDEXING PRIOR TO PRINTING OF TICKET.
— On the left-hand side of the Register

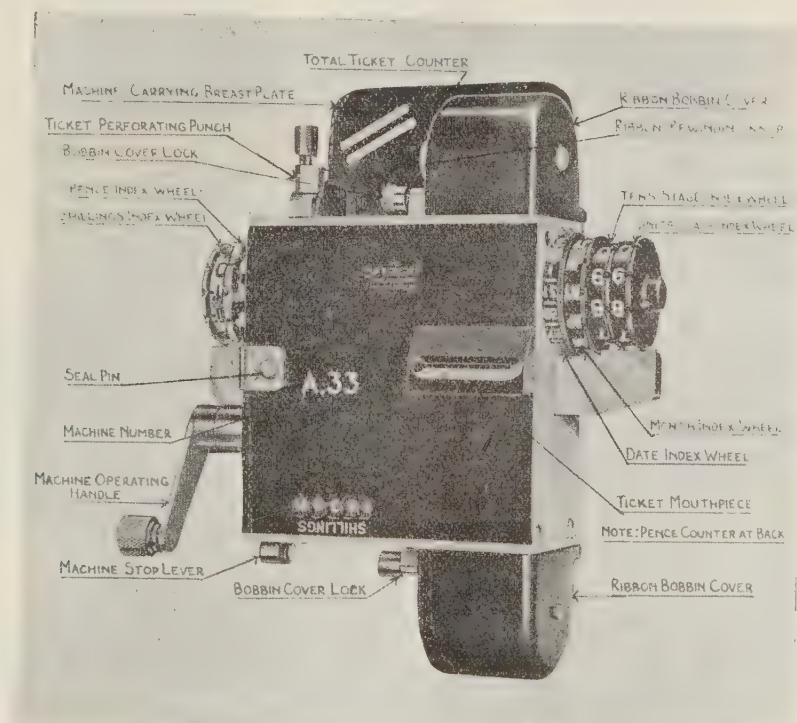
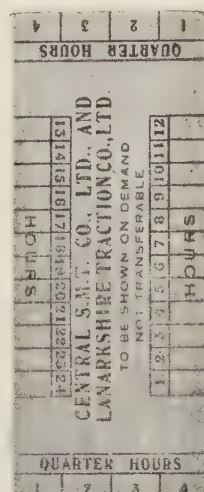
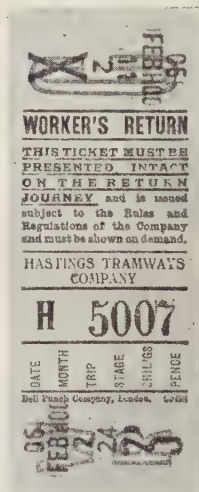
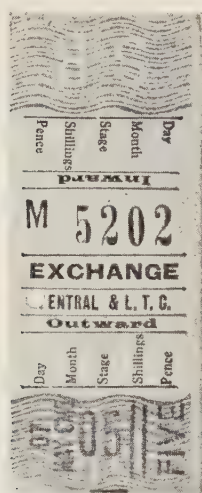


Fig. 520. — Portable « Setright » Register, for printing particulars of each journey.

are a number of indices. The wheels are set in the required position by turning them until the data which are to be printed appear at the top of the Register

handle cannot be moved; similarly the indexing wheels are locked as soon as the operating handle is moved from its idle position, thus making certain that the



Tickets for « Setright » Register. (Red. 4/5).

Fig. 521. — *Central & Lanarkshire Traction Co.'s exchange ticket.*

Fig. 522. — *Worker's return ticket, Hastings Tramways Co.*

Fig. 523. — *Back of return ticket showing time of use in hours and quarters.*

when worn by the operator. The various indices require setting as follows :

Month index. — At the beginning of each month;

Day index. — At the commencement of each day's operations;

Trip index. — At the beginning of each journey;

Stage index. — At each stage entered during the journey.

The fare-selecting wheels are placed on the right-hand side of the machine. These wheels are provided with fraud- and fool-proof locks which ensure that unless the indices are set in one of the correct positions, the operating

full value printed on the ticket is registered on the cash counter.

The following particulars appear opposite the pre-printed headings and are printed through the ink ribbon :

- The day of the month;
- The month and the year;
- The stage number;
- The number of shillings;
- The number of pence.

The printing ribbon is designed to allow of printing at least 80,000 tickets under normal conditions before renewal.

Fitting a new ribbon takes from 2 to 3 minutes.

capacity, placed in the lower part of the machine (fig. 524). Its overall dimensions are 325 mm. (12 7/16") height, and 200 mm. (7 7/8") width, handle excluded. There are two types, one without, the other with a check band with a 2,000-record capacity carried on bobbins in the bottom container and, of course, requiring additional wheels.

The main case contains the mechanism for printing and issuing the tickets and for printing the check band, the meters which automatically record cash collected, the number of tickets issued, and the transport tax in the case of tickets costing over 10 francs.

The fare printing elements are on one

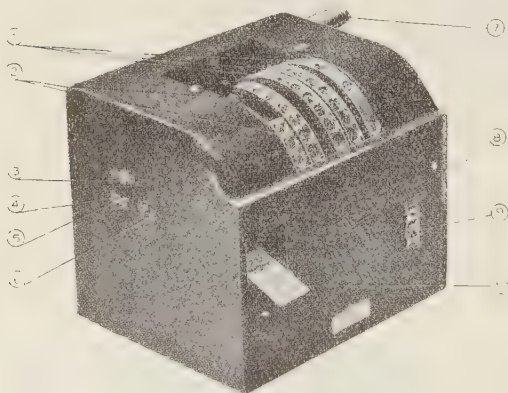


Fig. 528. — *C.A.M.P.* type machine for printing particulars of a journey when paper ticket is issued.

Legend :

1. Index wheels for making up the fare.
2. Index wheels for making up number of stage where passenger is to alight (Letter « R » applies to return tickets).
3. Route number.
4. Day of the month.
5. Number of the month.
6. Run made by the vehicle.
7. Operating handle.
8. Number of the machine.
9. Boarding point number.
10. Ticket mouthpiece.

of the sides; on the other, a variable number of index wheels show :

The number of the fare stage or station where the passenger boards the vehicle;

The number of the one where he alights;

The journey or route number;

The fare applied;

The day of the month and abbreviation of the month.

A single turn of the handle prints and ejects the ticket. The conductor detaches it and hands it to the passenger who, thanks to the pre-printed headings, can check the meaning of the figures that appear on it (figs. 525 to 527). Reading the difference between the numbers shown on the counters supplies the information needed for auditing. Statistics are obtained from the check bands which duplicate the items appearing on each ticket : number of trip, fare, etc. The data concerning some hundred tickets are printed on a strip one metre (about 3 ft. 4 in.) long.

The Massot-C.A.M.P. apparatus (fig. 528) is specially suited for long runs with tickets of different kinds. It is more compact than the former, and all parts, except the operating handle, are totally enclosed. Safety devices provide against tampering.

Rolls of blank paper providing 600 tickets each are used with it.

The alighting point and the fare being set by means of indices, a turn of the handle ejects the ticket, bearing all the particulars quoted under figure 528. The check band will serve for some 3,000 tickets and is easily removed when used up (fig. 529).

5. Indirect cancelling by dry-stamping. — Many road transport undertakings

use multi-trip tickets. Some have tickets with a space for each possible journey. After being marked with the factors corresponding to the one in progress, they become void for any other. This is often done by ink stamps; at other times the particulars are impressed in the spaces

Two index wheels, each numbered from 0 to 9, indicate the unit figure for the day of the month, and the unit figure of the trip. The numbers to be impressed are set by appropriate knobs. Four other figures show the number of the punch used.

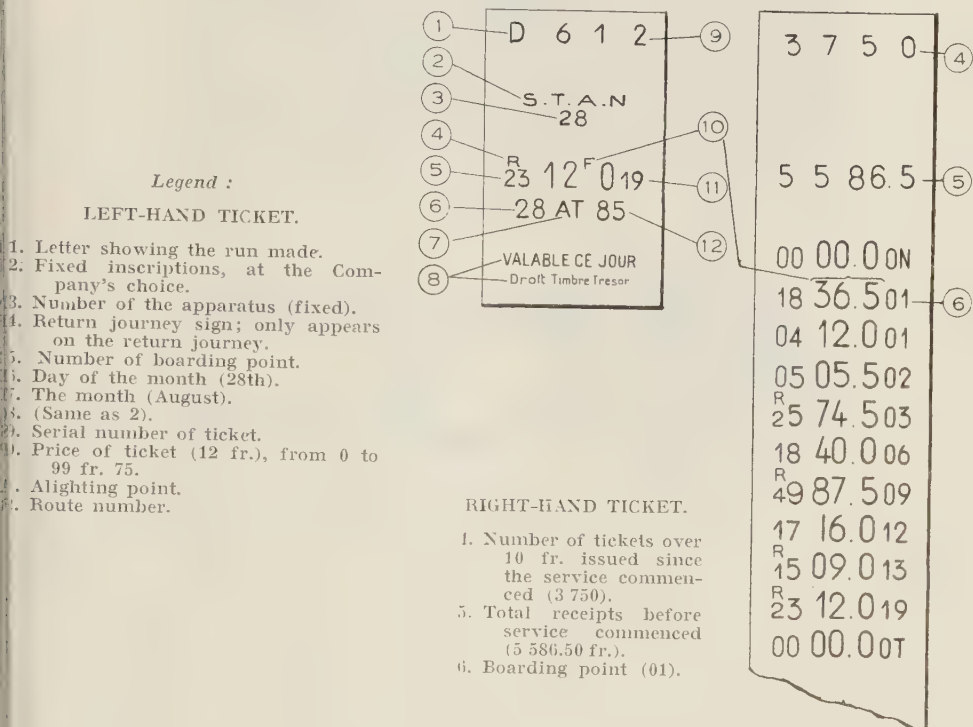
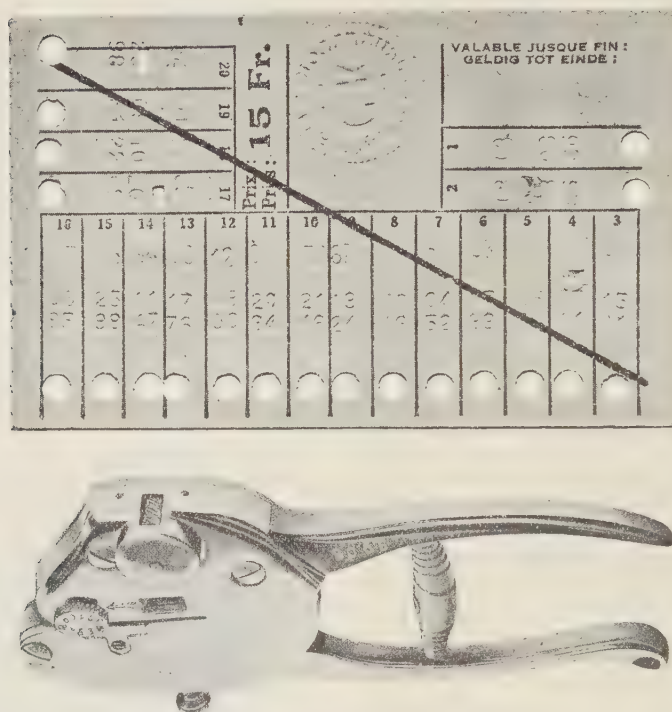


Fig. 529. — Ticket and check band of C. A. M. P. (P type) machine. (Red. 4/5).

concerned and soft cardboard is used for the tickets.

The recording punch of the *Brussels Tramways*, and other Belgian Companies, indicates the trip, the date and the conductor's number, and punches at the same time a 5-mm. (3/16") hole; a counter records each operation (figs. 530 and 531).

The average time to deal with a ticket is 3 seconds and a half. In 1937, the average percentage of passengers using 20-trip cards was 63.88 p. c. This figure is easily arrived at by taking the difference between the total number of passengers and those of the cards recorded for each route by each conductor.



Figs. 530 and 531. — 20-trip card ticket (Red. 3/4), and recording nippers — *Brussels Tramways Co.* The figures impressed by dry stamping and the Company's seal brought out.

PART G.

TICKET ISSUING ENTITIES.

CHAPTER XIV.

This only interests us as regards tickets issued by :

1. Operating Companies, at their booking offices or on their trains;
2. Non-operating Companies;
3. Company or private Agencies;
4. Foreign administrations.

1. Issue by the operating Companies.

— The first English Edmondson tickets did not bear the Company's name (*figs 51 to 56*); this was added later (*figs. 450 and 532*), and given prominence by the use of Gothic type ⁽¹⁾ (*fig. 156*), ornate monograms ⁽²⁾, or even coats of arms (*fig. 58 and fig. 449*). Such exaggeration caused reaction so that the title disappeared for a time but reappeared in the seventies in England, where it is now statutory. It is printed at the top of every ticket.

On the Continent, the Company's name was printed on the tickets from the outset, but the opposite course ensued. As the aspect of tickets was standardised in each country, or in certain regions of Germany, Switzerland and Austria, the Company's name was only used exceptionally, mostly on tickets of the smaller lines only.

Elsewhere, uniform rules governed the

method of indicating the issuing Company. Belgian tickets had a hole in the centre in order to facilitate tying them up in bundles and the Company's name was printed between the two circles which surrounded it (*figs. 76 and 77*); many a foreign Company copied this arrangement.

In Italy, a large initial letter, printed in the centre of the lower part, generally indicated the railway concerned, such as the « *Mediterraneo* » or « *Adriatico* » system. In France, the name or initial appeared in the left-hand lower corner (*figs. 456 and 557*).

International tickets generally follow the foreign railway's practice.

In America the Company's name appears on all tickets and often in full (*figs. 293 and 475*).

Besides ordinary tickets, Companies issue others to meet special cases. When a line is used by trains of both the owning and a foreign Company exercising running powers, tickets special to each class of train may be issued ⁽³⁾. This is done for statistical purposes or to allow the auditing department to apportion the receipts between the two systems.

A Company sometimes issues tickets for a journey forming a continuation of its own route but effected entirely on

(1) On the *Great Western Ry.* this lasted until about 1850, on the *Caradon Ry.*, 25 years more. Overseas British Companies also followed this practice (*fig. 453*).

(2) In particular the following Companies: *London and South Western, Maryport and Carlisle, Scottish Central, Great Northern, London and North Western, South Wales, South Devon, Great Southern and Western*, of Eire, and even in British India.

(3) Such as for *P. L. M.* or *French State* trains on the *P. O. Railway*.

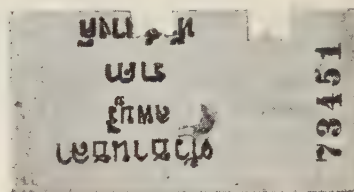
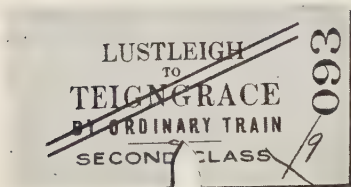
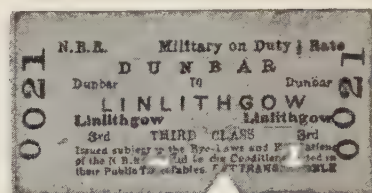
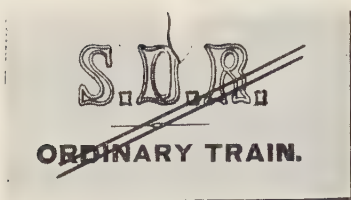


Fig. 532. — Back and front of a *Somerset & Dorset Ry.* ticket. (Red. 4/5). — Company's initials on back — Price entered (optionally) in writing on front — Early fifties. (Red. 4/5).

Fig. 533. — Example of badly arranged letterpress — *North British Ry.* (Red. 4/5) — Category: Military on duty.

Fig. 534. — Ticket entirely in Siamese type. (Red. 4/5).

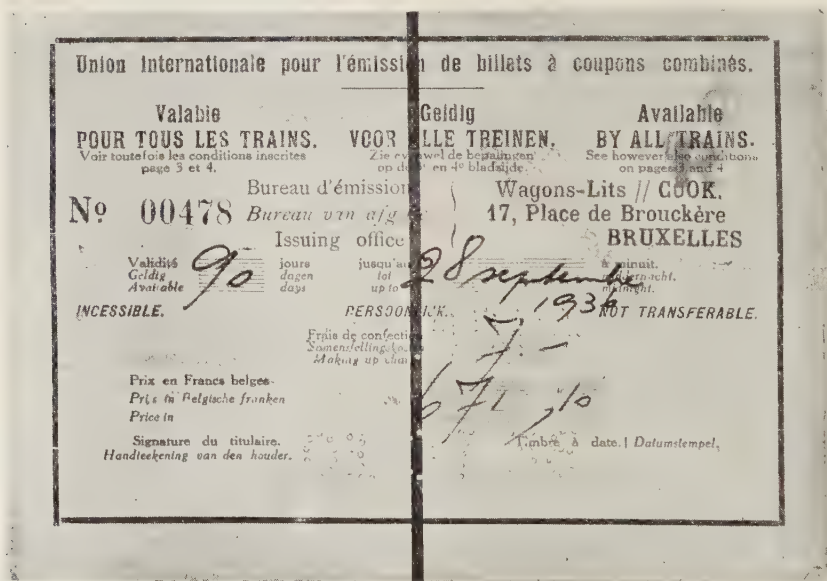


Fig. 535. — Standard cover of booklet of combined coupons. (Red. 3/4) — Issued by an agency (*Wagons-Lits/Cook*) — Vertical stripe showing it is « available by all trains » — Holder's signature — Dated by perforation.

another system; this occurs when a passenger enjoys certain concessions on its own line, but not beyond. It is obviously not possible to issue a partly full-fare, partly reduced-fare through ticket.

them; in other cases the initials of the non-operating undertaking are punched through each bundle of tickets.

The VEREINSREISEVERKEHR (Service of the Railway Union), had standardised, before the War, the issue of international tickets. This organisation was managed by the German Railways ⁽²⁾.

The INTERNATIONAL UNION FOR THE ISSUE OF COMBINED COUPON TICKETS was formed in 1921 by 19 parties; it now includes 30 Companies or Administrations. Each

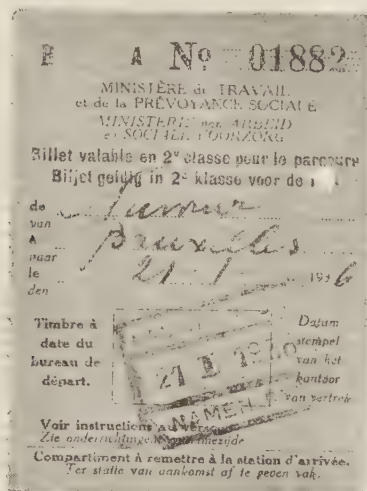


Fig. 536. — Blank ticket issued by a Govt. department. (Red. 3/4) — Date stamped — Available on the Belgian Rys.

Thus the French Railways issue tickets available from the frontier to certain important Belgian stations, the latter doing the same for the journey from the frontier to Paris. The same thing can occur between Companies in the same country, especially between main and light railways ⁽¹⁾.

2. Issue by non-operating Companies. — These tickets are subject to extra checking. They are sometimes stamped by the working Company so as to validate

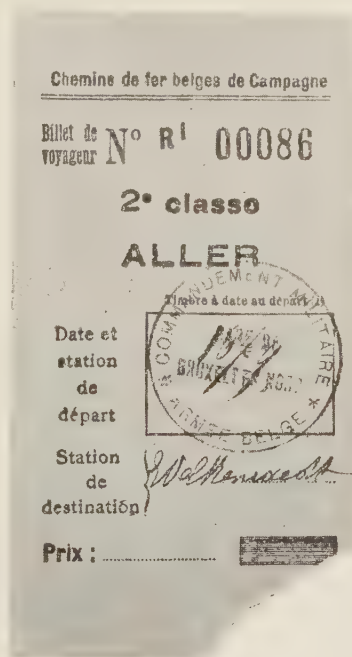


Fig. 537. — Blank ticket issued by Belgian field railways (Red. 3/4) — Date-stamped — Handwritten destination.

(1) The Belgian National Railways Co. and the Belgian National Light Railways Co.

(2) The Verein Deutscher Eisenbahnverwaltungen was formed in 1846 and its name, taken in 1847, was changed in 1932 to that of Verein Mitteleuropäischer Eisenbahnverwaltungen, which comprises 110 member Administrations, which include, besides the Central European ones, those of Switzerland, Denmark, Sweden and Norway, who took up membership in 1929.



Figs. 538 and 539. — Similar tickets issued by the *Antwerp Tramways Co.*, and the *Compagnie des Tramways d'Anvers* which took over the working about 1884. (Red. 3/4).

Fig. 540. — Ticket issued by a Govt. Dept. over the *United Railways and Electric Co.*, Baltimore.

of them furnishes coupons free to its Associates and awards a 3 to 5.5 % commission to Agencies which issue tickets on their own account.

There are five classes of coupons :

- Singles;
- Returns;
- Circular trips;
- Combined circular and return trips;
- Broken journeys.

They have all been standardised (fig. 535). The coupons have check stubs which are retained when they are delivered to children; others are provided with route check stubs.

Tickets for members of a party are overprinted with a red star.

Return tickets have a central vertical white band 10 mm. (3/16") wide.

Tickets available by all trains have a red vertical line 1 mm. (3/64") wide.

3. Tickets issued by Agencies. — *Cook's Agency* was one of the earliest to issue tickets and the 1841 ticket shown in figure 178 was one of its first excursion tickets. The *Gaze Agency* followed and, for a long time, these two were the only Agencies to which certain countries, such as Switzerland, furnished special tickets. As a matter of fact, many Companies print and supply the tickets used by the Agencies. More recently, the latter have been authorised to print certain classes of tickets themselves, especially books of combined coupons and fixed destination booklets. To validate and keep a check on them, the Agencies have to submit them to the Railway Companies concerned, who, when taking stock, dry-stamp them (figs. 92 and 93). Then only have they become proper tickets which are delivered and debited to the Agencies, less 3 to 5.5 % commission.

4. Issue by Administrations foreign to the railways. — These are mostly war-rants, got out by Administrations authorised to do so either by law or by some clause in the Companies' statutes.

Direct issue of tickets is exceptional (figs. 536 and 540), save in occupied territory (fig. 418), where the Authorities always do so, or on field railways (fig. 537) or over railways requisitioned by Government in war time (fig. 149).

In most cases, to check the requisition, they honour, the Companies issue exchange tickets in return for them (figs. 37, 410).

PART H.

THE PHYSIOLOGY OF TICKETS.

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* * *

CHAPTER XV.

TICKETS LETTERPRESS.

1. General. — Whatever the text on a ticket may be, it is essential to choose a suitable arrangement of type, so that it appear clear and distinct. This is particularly important for Edmondson tickets, whereon space is very limited. A glance at figure 529 shows what ought not to be done in this respect. Yet, by a judicious choice of type, colours and illustrations, satisfactory results are obtained.

In addition to indispensable information the text on Edmondson tickets may possibly include :

- a) Extracts from bye-laws or special conditions which govern the use of the ticket;
- b) Recommendations to the passenger;

- c) Maxims, proverbs or quotations.
- d) Advertising matter.
- e) Pictorial matter.

Extracts from regulations are essential; recommendations are not printed as frequently, nor is advertising or pictorial matter, but certain paper tickets, especially in American booklets or strips, bear any number of rules and recommendations. To get them all in, very small type is necessary, so small that the public loses interest in it.

There is quite an art in getting onto a ticket of $1 \frac{3}{16}'' \times 2 \frac{1}{4}''$, having a surface of scarcely 2.7 sq. in., without unduly crowding it, the amount of text required, especially as it is essential that any particular item must be grasped at a glance by the passenger or the official whom it may concern. Yet the back of

the ticket is not often used, because « the passenger must turn it over to see what is printed there ». As, in taking hold of a ticket, there is a 50 per cent chance that the back be uppermost, the argument is hardly a sound one.

Besides this a ticket does not remain intact long. The date is added to it — in a specially provided space — and what is worse, each official who examines it punches it or removes some portion of it. Yet such treatment should not interfere with the legibility of the remains. In countries such as Italy and Canada, special spaces are reserved for the nippers. But elsewhere, the body of the text should be so arranged that it does not reach to the edges of the ticket.

When a stub has to be removed the items necessary for checking must appear both on the stub and on the body of the ticket (figs. 457 and 458).

On some *L. M. S. Ry.* tickets there is a curious survival of requirements that have disappeared. A semi-circle used to be cut out of the upper edges of its inset tickets (fig. 558), which compelled the Company to space its initials accordingly and this practice was continued long after inset tickets had been given up (*fig. 14*).

2. *Language.* — The « International Convention », which binds only those adhering to it, lays down that the cover of booklets of coupons must be worded in the languages of the countries in which the journey begins and ends (fig. 535). The intermediate leaflets must be in the language of the country where the journey begins and may, at will, be in

the language of the country passed through as well. These rules are not compulsory for internal journey tickets, nor do they apply to Companies outside the *Union*.

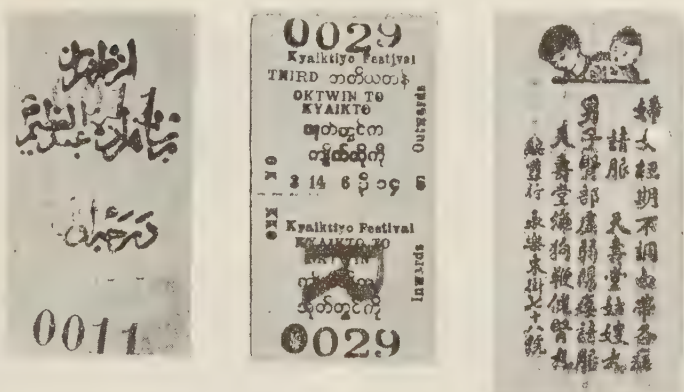
EDMONDSON TICKETS are generally printed in the language of the country of issue only, making it difficult for foreigners to understand them, and even impossible when the text is not in Roman type ⁽¹⁾ (figs. 534, 541 and 543). This drawback is often met by using bilingual text, the second language being one understood internationally, such as German in central Europe, French in the near East, English in the Middle and Far East (figs. 544 and 547). Some countries too, have two if not three, official languages, and their tickets must be understood by all their people. The question is, therefore, an important one and has been solved in three different ways.

The first consists in using the language of the district in which the ticket is issued as is done in Switzerland, where the *Federal Railways* have tickets printed in German, French or Italian, but one of these languages only on each ticket. The same method is now applied in Belgium for French and Flemish tickets.

The second system consists in giving the translation of each item on the ticket immediately after it, even if non-Roman type is used for one of the languages. Thus Franco-Flemish tickets are found in Belgium, Erse-English tickets in Eire, Anglo-Dutch in South Africa and, with foreign type, Franco-Chinese in Indo-China and Anglo-Burmese in Burma (fig. 542).

(1) In Europe one finds tickets printed entirely in Greek (fig. 549) or Cyrillic types. Many countries have tickets printed in Arabic. Bilingual tickets are used in Egypt, the Sudan, and Tunis; in Irak, the tickets are in Arabic and English; in Syria, Turkey and Iran, in Arabic only (fig. 541).

Most Japanese (figs. 69 and 365), Chinese (fig. 543), and Corean tickets have no Roman text. All kinds of local type are seen on Burmese (fig. 542) and Indian (figs. 544 and 547) tickets, usually with English in addition.



Tickets in foreign type. (Red. 4/5).

Fig. 541. — First Iranian tickets (*Persian Railways & Tramways Co.*), 1887 — Arabic type only.

Fig. 542. — *Burma Railway tickets* — Bilingual : English and Burmese — Category : festivities.

Fig. 543. — *Hong Kong Tramways ticket*, in Chinese only.

The bilingual text of international tickets is generally arranged in this way, but this is not practicable when there is too much of it, as with the first Belgian scheme tickets. So part of the text was transferred to the back, and not long after, tickets were printed with each face bearing all the particulars in one of the two languages.

The *Warsaw-Vienna Railway* had tickets printed in German on one face and Polish on the other; Czechoslovakian tickets are likewise printed in German and Czech. This is the more rational method (fig. 89), and is particularly suitable when one only of the languages uses Roman type. For instance, in Siam, English is used on one side of the tickets, and Siamese on the other.

On bilingual tramway tickets, the translation usually follows immediately after the original text; the American band tickets give the Spanish or Franco-Canadian translation in an adjacent column (fig. 253).

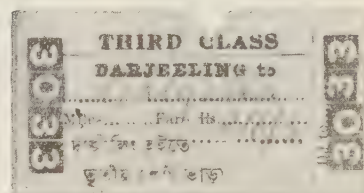
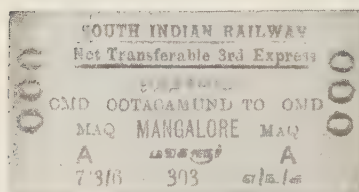
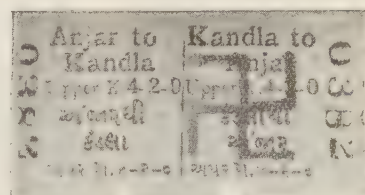
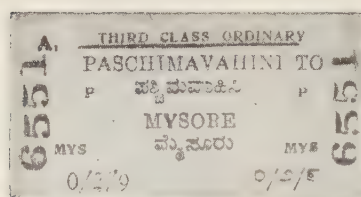
There are few trilingual tickets save

in Palestine (Arabic, Hebrew and English, fig. 550), in Cyprus (Greek, English and Cypriot) and in India (English and a couple of dialects).

The SPELLING of names has changed with the rulings of each country. Apart from such drastic changes as Oslo instead of Christiania, and Petrograd, then Leningrad, instead of St. Petersburg, phonetic spelling is being applied to a certain extent in Holland, Belgium and Germany. The old « Coeln » has been « Cöln », then « Köln », and the spelling of all Dutch and Flemish names is being simplified.

3. Extracts from bye-laws. — It has always been the practice to state on the tickets that they are issued subject to the Companies' bye-laws; the announcement is either on the front or the back (fig. 13); in the latter case the fact is often pointed out on the front by means of a caption such as « see back » (fig. 569).

As it is impossible to produce the entire text, only the most important



Bilingual tickets with type in English and in various Indian dialects. (Red. 4/5).

Fig. 544. — *Madras & Southern Mahratta Ry.* — In English and Mahratti.

Fig. 545. — *South Indian Railway* — Category: Express train.

Fig. 546. — *Kutch Railway* — Overprinted with the ancient Hindu sign, the Swastika.

Fig. 547. — *Darjeeling-Himalayan Ry.* — Blank ticket.

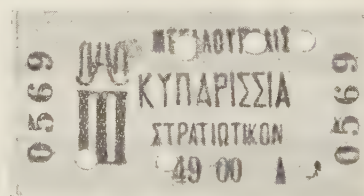
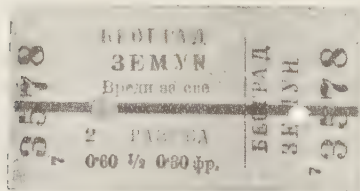
clauses appear, stipulating the obligation to show the ticket on request and even to deliver it to the Company's servants, or stating its non-transferability, the ticket being personal to the holder. Warning notices prohibiting tipping, etc., used also to be added where space was available (figs. 3, 4 and 48).

It is amusing to note that the first Belgian railway tickets followed earlier customs so closely that the Company's servants continued to call the carriages of

various classes by the names that had previously been used for horse-drawn vehicles. A charabanc was a 3rd-class coach, a stage coach (diligence) a 2nd-class one, and a « coach » (berline), a 1st-class carriage. Thus smoking was prohibited

... in stage coaches and charabancs (fig. 2).

Special classes of tickets bear particulars of the rules or regulations specially concerning them. Cheap tickets advised



Tickets entirely printed in non Roman type. (Red. 4/5).

Fig. 548. — *Yugoslavian State Railways* — Available by any train — With detachable stub for issue to a child.

Fig. 549. — *Athens-Peloponnesus Ry.* — Large Roman numeral indicating class travelled in

the bearer that the Company did not accept any liability in case of accident. It may be noted, however, that public opinion has recently induced the English Companies to grant concessions in this matter. From May 1st, 1933, their non-liability was no longer maintained against holders of summer return or monthly tickets. In April 1938, the four main-line Companies decided to adopt the same course, making it retrospective as from December 1st, 1937, for day, half-day, evening and workmen's tickets, so that non-liability now only applies to the free passes or staff tickets, whether paid for or not.

Generally speaking, each Company sta-

Advantage is taken of any increase in the size of the tickets to print a number of further particulars. Coupon and other booklets are noticeable examples.

4. Recommendations. — This class of statement is milder in character than the above, facilitates the work of the staff, and promotes the safety of passengers, for instance :

Passengers should ascertain if they have to change carriages and where (*London Brighton and South Coast Ry., 1861*).

Many American tickets beseech the passenger to take care of his countermark or ticket

Which identifies accommodation purchased (*figs. 6 and 8*)

and the slogan

Read your contract (*fig. 514*)

is of interest to all.

Urban transport tickets, more than any others, bear a number of these admonitions ⁽¹⁾. In Paris they tend to expedite the working :

Do not obstruct the passages and the service will be speeded up.

Be ready to leave your seat so as to alight as soon as the vehicle stops.

In London (*L. C. C.*) passengers will please :

- Pass along the passage;
- Have the exact fare ready;
- Not stand in the vestibule of a vehicle;
- Alight quickly.

On the *British Columbia Electric Railway Co.*, we find :

- 1. Stop.
- 2. Look.
- 3. Listen.
- 4. Wait until the car stops.
- 5. Make sure another car is not coming from the opposite direction.

(1) *Transports en commun de la Région parisienne; London Passenger Transport Board.*



550. — *Palestine Rys.* — Coupon in three languages : English, Hebrew and Arabic. (Red. 3/4).

es on its tickets that its responsibility for accidents does not extend beyond its own system (*fig. 425*), and on transfers, that connection is not guaranteed and that they must be used immediately or else penalty or prosecution will follow (*fig. 21*).

Platform ticket holders may not enter the trains (*fig. 595*); some American countermarks state that they must be kept in sight (*fig. 285*).

This railway prints « don'ts » on its scholar tickets :

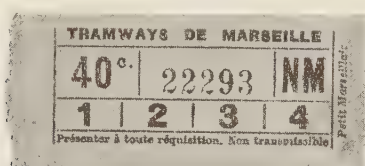
Don't play on the line.
Don't touch any cables.
Don't cross behind a car.
Don't alight from a car in motion.
Don't take any risks.

5. Maxims and proverbs. — Some Companies print moral maxims on their tickets. In 1928, the *São Cristovão Co.*, Brazil, issued tickets saying for instance :

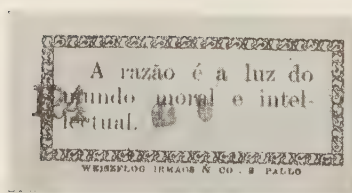
Reason is the light of the moral and intellectual world (fig. 552).

The *Barcelona-Ensanche-Gracia Tramways* quoted several maxims on the back of each of their illustrated tickets :

Get rid of your faults that people may love you.



Trois choses ont ensemble,
dès le commencement,
paru sur la terre : l'homme,
la liberté, la lumière.
MAXIME CELTE.



Tickets with maxims on back (Red. 3/4).

Figs. 551 a) and b). — Front and back of a *Marseilles Tramways* ticket, issued during the War.

Fig. 552. — Back of a ticket of the *São Cristovão Tramways* (Brazil, 1908).

To meet one grateful action compensates for ingratitude.

More recently, during and after the War, the *Marseilles Tramways* printed a whole series of them (fig. 551) :

Retaliation is the justice of insults.
Ignorance begets presumption, and knowledge, modesty.

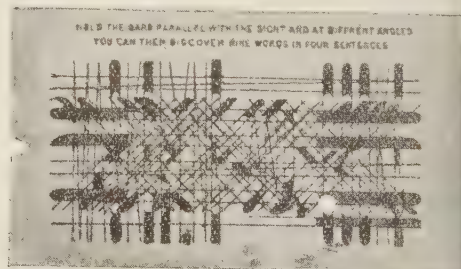
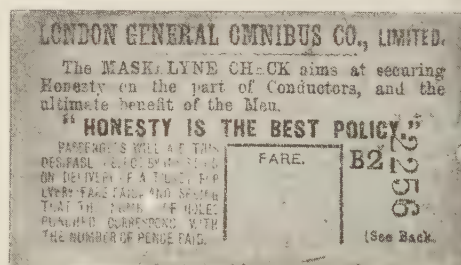
Don't judge by appearances.

In 1875, The *London General Omnibus Company* turned such sayings to account to promote better working (fig. 553). Drawing attention to the fact that

Honesty is the best policy,

it asked passengers to insist on receiving a ticket and see that it corresponded with the fare paid.

6. Advertising. — A Company's tickets



Figs. 553 and 554. — Front and back of old card ticket of the *London General Omnibus Co. Ltd.* (Red. 4/5) — Advertising matter : puzzle on the back — Passenger cooperate in checking the conductor.

form an excellent means with which to advertise, and they can serve the purposes of commercial advertising as well.

It is as essential to use special type for this, as it is to do so for the ordinary text of a ticket. Not only must any advertising be noticeable, but it must not be confused with the particulars relating to the journey. Negative type and vignettes are frequently called upon, besides colour and illustrations.

6. a) **Placing the advertising matter.** — Although space is limited, especially on Edmondson tickets, advertising matter can be worked in both on the front and back, insets inserted into them, or supplementary advertising sheets added.

Advertising matter may be inserted in the text itself (fig. 212), sometimes in a second colour, or it may be printed along the edges of Edmondson tickets (fig. 563). When there is not enough space, paper tickets are made larger at the top or bottom, or at either side.

Advertising matter may also be overprinted right across, in coloured ink, through which the black ink of the ticket's text can be read.

Advertising on the back of Edmondson tickets is exceptional. A Company selling insurance tickets was the first to rent this space since 1871, from the *Great Western Railway*, and « Lipton's Tea » took up the free space on others. Advertisements next appeared on Swiss and Belgian Light Railway tickets. After all, a ticket only remains a relatively short time in the holder's possession, and to awaken his interest it must be capable of amusing him or at least of attracting his attention.

Road transport tickets may be retained, so advertising on them is frequent, whereas it is exceptional on railway tickets.

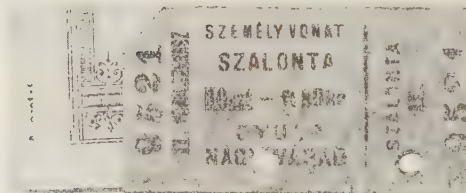
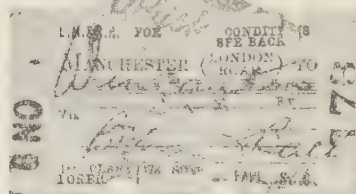
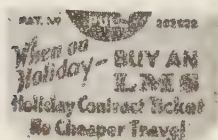
INSET ADVERTISEMENTS. — So as to increase the space available for advertising matter, the *Alta Italia Railway* had tickets made in 1883, with a pocket on the back, containing a thin folded sheet of advertisements: it was hoped that the passenger, if a man, would withdraw it during some idle moment or, if a lady, out of curiosity. There were 20 separate advertising spaces on each side of the sheet, of which 10 000 were printed, to be had at 15 francs each.

The pocket was somewhat expensive to make, so other tickets were manufactured without it; instead of placing the sheet in the pocket, it was slipped into the ticket itself which was hollowed out for the purpose. The Italian *Mediterranean Railway* first used them in 1899 (fig. 556); they appeared in 1900 at the Paris Exhibition (fig. 564), next on the *P. L. M.* and the *Hungarian State Rys.* in 1908 (figs. 557 and 559).

The same idea has recently re-appeared in a modified form, a thin card inset tak-



fig. 555. — Old tickets issued in Rome, about 1875. (Red. 4/5) — Printed by heliogravure with illustrated fashion advertisements on the front.



Hollow tickets containing tissue paper advertising sheets. (Red. 4/5).

Fig. 556. — *Mediterranean Railway*, 1889. — This was the standardised type of many Italian lines of the period.

Fig. 557. — *P. L. M. Railways* ticket; 1908.

Fig. 558. — Ticket and inset, *L. M. & S. R.* — Category : Blanks for through journey.

Fig. 559. — *Hungarian State Rys.* ticket, 1908.

ing the place of the folded sheet of advertisements. The *Insets Development Co., Ltd.*, was formed in London to work the patents covering the ticket machines and the special *Mones-Cross* tickets ⁽¹⁾.

Should the passenger lose his interest

in these inset tickets, the Company might stimulate it by offering prizes to persons collecting them, or by insuring the holder against accidents on condition that he had previously withdrawn the inset. The Company's prospectus estimated at 800 mil-

⁽¹⁾ British patents, No. 262,522 for the machines and 310,789 for the tickets.

hour. The cost price was estimated at 1/5 to 1/4 penny per thousand, or at 3 shillings, inclusive of all overhead charges and commissions.

The scheme was given up after a short while.

PAPER TICKETS may be DUPLICATED with a sheet of thin paper, intended solely for advertising purposes, and lightly attached to them, enabling both to be read.

The Italian engineer Monteverde even patented a process for the purpose, which was tried by the *Florence Tramways*. The advertisement sheet was attached to the outer edge of the tickets and bound in blocks with them (fig. 560).

6. b) Advertising by the Companies. — DIRECT ADVERTISING consists in printing, on the back of Edmondson tickets, some text setting forth the advantages offered by certain fares or train services ⁽¹⁾. Red letterpress is often used so as to attract attention.

Certain English road transport undertakings appeal to sentiment. The « Thank you » of *Woodbridge*, and the declaration by the *Liberty Buses* that they are

Owned, driven, run and maintained by ex-service men

are characteristic instances (figs. 564 and 565). The *Toronto* tickets which say that

In Toronto nobody pays rates to support the public transport services...

are of the same kind.

A fine landscape or monument to be seen on the system is often reproduced on paper tickets (figs. 440 and 566); and souvenir tickets are even issued with these pictures. In Austria, picture-post

(1) *Metropolitan Ry., Southern Ry.*

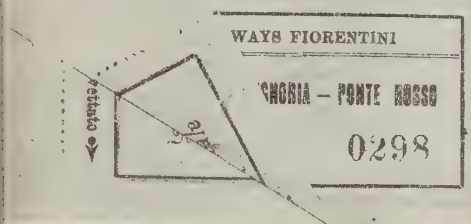


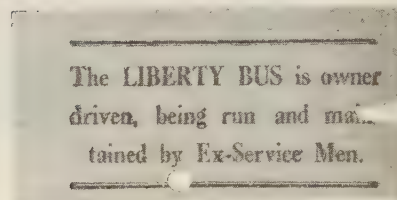
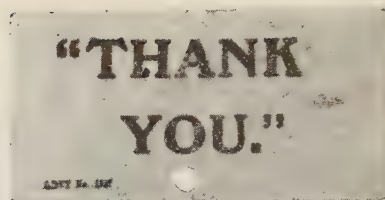
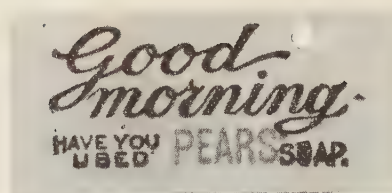
Fig. 560. — Monteverde patent ticket with duplicate advertisements — *Florence Tramways*. (Red. 3/4).

Fig. 561. — Hollow ticket containing sheet of advertisements — *Moët & Chandon's boats*. Paris Exhibition, 1900 (Red. 4/5) — Engraved by Devambez.

lions the number of tickets issued annually in Great Britain and at 7,480 millions those issued in other parts of the world, excluding France, India, Australia and South America.

The prospectus stated it entered into contracts with the *Great Indian Peninsula Ry.* (68 millions of tickets annually), the *London, Midland and Scottish Ry.* (for 250 millions per year) and the *Belfast and County Down Ry.* (for 1 1/2 million).

Figure 558 shows an *L. M. S. Ry.* ticket and an inset. The machine producing them was of the four-bank type, and working to capacity produced 4 times 208 — 832 tickets per minute or 50,000 an



Advertising on soft card tickets. (Red. 4/5).

Fig. 562. — The well known « Pear's soap » advertisement on the back.

Fig. 564. — A message on the back — *Bird Buses*, London.

Fig. 563. — « Bireka » type ticket — *Nero-berg Ry.* — Advertisements along the edges.

Fig. 565. — Message inspired by feelings the prevailing — *Liberty Buses*, London.

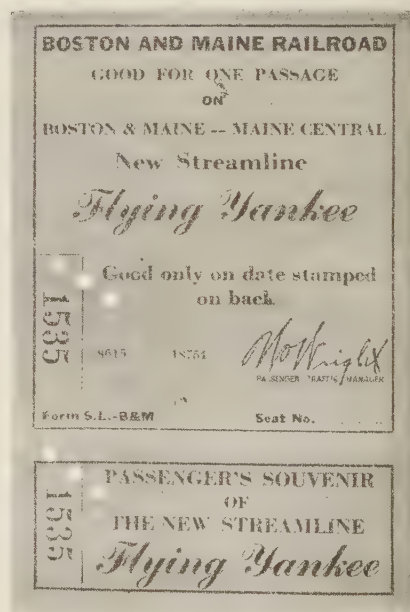


Fig. 567. — Souvenir ticket of a trip in the « Flying Yankee », *Boston & Maine and Maine Central*. (Red. 3/4) — Metallized aluminium paper.

Fig. 566. — Ticket with halftone illustration (Red. 3/4) — Heiligenblut, Austria. Available for five days.

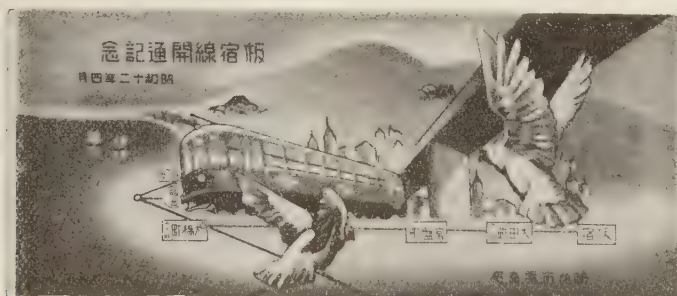


Fig. 568. — Japanese ticket commemorating opening of a new line in Tokio. (Red. 3/4).
Offset three-colour printing.

card tickets have even been produced, with a fine picture on the back, the front being a postcard with the ticket items printed in a corner (*Hungerburg Ry., Innsbruck*).

The *Chicago and Eastern Illinois Railway*

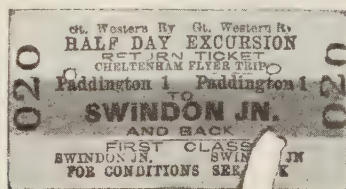
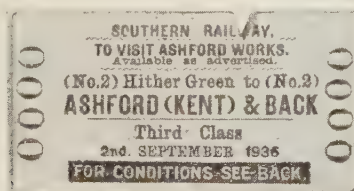
Hopes that its excursionists will patronise it again.

It adds a special tear-off advertisement form, and asks its patrons to post it filled in with their name and address.

Finally, in connection with certain trains, souvenir advertisement tickets are issued for inaugural trips (fig. 568), or for limited trains, like the metal foil ticket of the « *Flying Yankee* » (fig. 567).

INDIRECT ADVERTISING BY THE COMPANIES.

This form of advertising, inevitably the most effective, is derived from circumstances, the ticket merely giving a concrete form to an idea that happens to be afloat. Thus special tickets are issued for excursions organised for visiting en-



Indirect railway advertising. (Red. 4/5).

Fig. 569. — Visit to Ashford Works on date shown — *Southern Railway*.

Fig. 570. — Centenary of railways. — *Railway propaganda*.

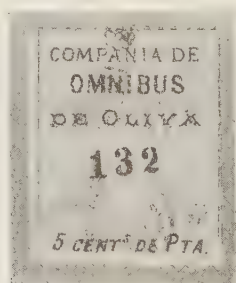
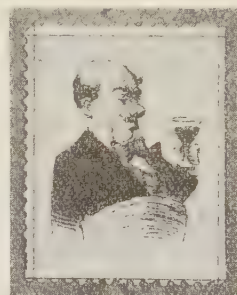
Fig. 571. — Half-day excursion, returning by the « *Cheltenham Flyer* », *Great Western Ry.*

gineering features or works (fig. 569); for propaganda trips to popularise certain crack trains such as the « Cheltenham Flyer » (fig. 571), or free travel in special trains to holiday resorts which the Company wishes to develop. Such trips are even run to places where land is being divided up into lots, in order to raise its value (fig. 572).

Commemorative tickets were printed on the earliest Edmondson presses when the Railway Centenary occurred (fig. 570).



Fig. 572. — Free ticket, Buenos Ayres & Belgrano Ry., 1907 — For purchasing lots (Red. 4/5).



Figs. 573 and 574. — Back and front of chromo-lithographed tickets of the Oliva Omnibus Co., Madrid — Issued about 1875. (Actual size.)

MEANS OF INCREASING THE SALE OF TICKETS PURCHASED FOR THEIR OWN SAKE AND NOT FOR THE ACCOMMODATION THEY GIVE A RIGHT TO. — In early years, Transport Companies sought to attract patronage by the most unexpected means and incited the public to buy tickets, even though they were not

going to use them. With this object they used the publicity ideas current at the time.

From 1865 to 1880 there was a craze for collecting pictures; so, prizes were offered for the most complete series that had been got together. The Liebig chro-

molithographs, pictures in packets of cigarettes or of chocolates, *Tuck's* picture postcards, all come from the same idea. If less is known of the activities of the early tramway and bus Companies in the matter, it is because their pictorial tickets, always much sought after, are no longer to be found (figs. 573 to 576); we shall describe them in chapter XVIII, which deals with illustrations.

RECREATIVE PUBLICITY. — Another way to attract attention to tickets was to print puzzles or riddles on them. There were tickets of this kind in London — those of the « Egyptian Hall » — and in Antwerp, where a number of series were printed, each with a person's face, concealed in the design, and which the passenger tried to discover (figs. 554 and 577).

LOTTERY TICKETS. — The vogue of the lottery was soon taken advantage of. At Rio de Janeiro it was such that lotteries were prohibited. This induced the *Zoological Garden Society* to print booklets of 25 tickets, each showing a different animal. Lots were drawn daily and the holders of the winning animal drew 24 times the money they had put down. Without worrying about visiting the gardens the public kept on buying and buying. And the Authorities renewed their prohibition again and again.

The Tramway Companies next took up the idea, but without going as far as to start a lottery. They also printed sets of tickets belonging to given series each bearing a different picture. Thus sets of animals were issued (*Carris Urbanos Co.*, fig. 273), collections of portraits of sovereigns or of comedians (figs. 500, 501 and 635), music hall artists (figs. 637,



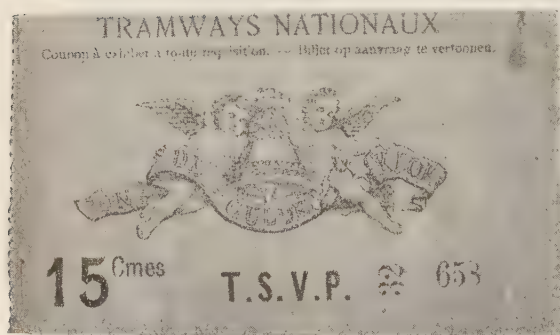
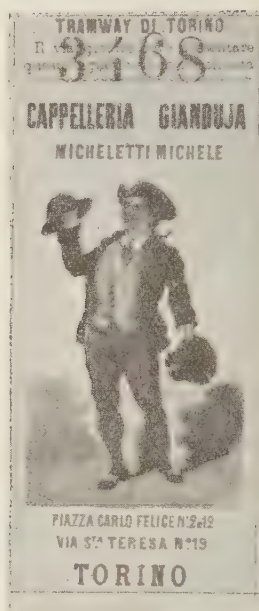
Fig. 575. — Tickets issued by the *Oliva Omnibus Co.*, Barcelona, about 1875, with chromo-lithographed illustrations. (Red. 4/5).

643 and 644) and views of towns (figs. 270 and 275).

The idea of combining a lottery with tickets continued to spread over Central and South America. Sometimes the tickets bore numbers which participated, through the medium of the Company, in official lotteries; sometimes the Companies gave a portion of an actual lottery ticket in exchange for packets of used tram tickets [page 705 (169) and figs. 384 to 386].



Fig. 576. — Old lithographed tickets issued in Madrid, with costumes of characters in the light opera « *La Mascotte* ». (Red. 4/5).



Advertising on National Tramways tickets, Antwerp. (Red. 3/4).

Fig. 577. — Puzzle on back — About 1878.

Fig. 578. — Advertising in the text on front.

European lotteries also involved transport tickets. A large Paris daily set up competitions with *Metro* tickets and offered a daily prize to the holder of 3 tickets selected at random.

Fig. 579 a) and b). — Old Turin Tramway tickets, about 1875, with illustrated advertisements in chromotype. (Red 4/5).

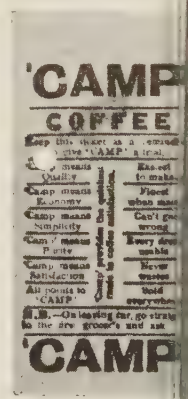
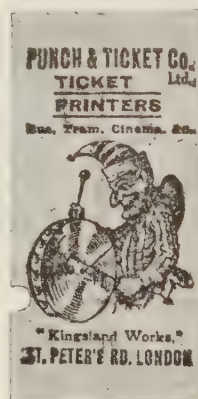
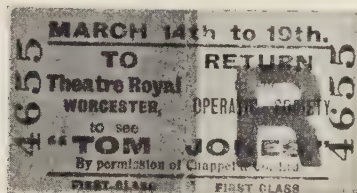
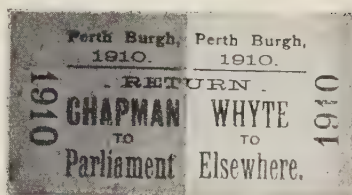
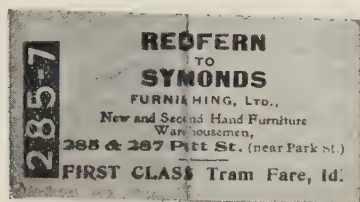


Fig. 580. — Printer's humorous advertisement on back. (Red. 4/5).

Fig. 581. — Back of London ticket, advertising being in the form of imitation fare tickets.



Using imitation Edmondson tickets for advertising. (Red. 4/5).

Fig. 582. — An Australian furnishing Co.

Fig. 583. — Scottish political canvassing.

Fig. 584. — British theatrical advertising.

6. c) Commercial advertising is particularly developed in England, on the backs of road transport tickets; it is often

humorous, such as the advertisements of a printing establishment or a well known soap manufacturer (figs. 580 and 562).



Further railway ticket advertising (Red. 4/5).

figs. 585 and 586. — Uniform fare coupon. Manhattan Railway, and « Sporting and Turf Record » advertisement.

Safety background in both cases.

GRATUITOUS TICKETS. — In 1855, French interests formed the *Compagnie Générale des Omnibus de Londres* ⁽¹⁾ which endeavoured to improve the wretched omnibus services then existing in London. They introduced the correspondence ticket system (of which more elsewhere) and from Jan. 1st, 1857, started selling tickets in advance with a discount of 2 shillings in the pound. It is said as many as 10,000 tickets were sold at the Company's Strand office the first day.

The stores were not slow to put this to use for advertising purposes. Wholesale manufacturers and particularly drapers and haberdashers purchased packets of discount tickets and retailed them to

(1) For fear of hurting public feeling, the cars bore an English title « The London Omnibus Company ». And in 1858, the Company was turned into a British concern.

their patrons. They even went so far as to give them for nothing. Towards June, the Company thought of reconsidering their decision and in October, the advance sale of discount tickets was discontinued.

DOUBLE-PURPOSE ADVERTISING. — This

concerns both the Transport Companies and either advertisers or statesmen, and consists in tickets issued in imitation of a railway or tramway ticket. The idea has often been used and is not without effect especially during election time (figs. 582 to 586).

(To be continued.)

Method recommended, by the Central European Railway Union, for calculating permanent way components.

(Verein Mitteleuropäischer Eisenbahnverwaltungen),

by P. KANDAOUROFF, Engineer, Paris.

In the « *Organ für die Fortschritte des Eisenbahnwesens* », No. 7, of the 1st April 1937, Mr. Ch. H. J. DRIESSEN, Chief Permanent Way Engineer of the Netherlands Railways, gives particulars of the new methods recommended by the Technical Commission of the Central European Railway Union for calculating track components.

These formulæ are based on a large number of experiments and detailed investigations; they are very simple and consequently of very great practical value, and are reproduced below :

The bending moment under the load of an intermediate wheel is calculated according to the formula :

$$M = \frac{12 m \cdot n - 7 (m + n) + 4}{16 [3 m \cdot n - (m + n)]} \times G \cdot a.$$

For a wheel of an end axle, the formula to be applied is :

$$M = \frac{12 n - 7}{16 (3 n - 1)} \times G \cdot a.$$

The letters have the following meanings (fig. 1) :

M = bending moment in kgr./cm.

m and n = the ratio of the distance between the centre of the axle causing the bending moment and that of the next pair of wheels on each side of it to the deeper spacing (centre to centre).

G = pressure of the wheel causing the moment (half the axle load), in kgr.

a = distance between centres of sleepers.

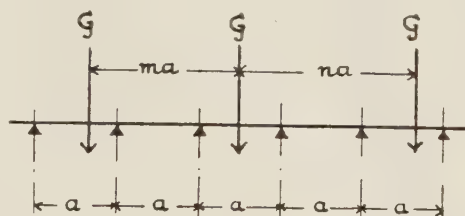


Fig. 1.

The coefficient of increase to allow for speed is to be calculated from the formula :

$$K_v = 1 + \frac{V^2}{30\,000}$$

V being the speed in km./h.

In the case of worn rails, the fatigue strength should be limited to 1 500 to 1 600 kgr./cm² (21 335 to 22 760 lb. per sq. in.) when taking the speed into account by introducing the coefficient of increase given above. In the case of new rails when the speed is allowed for, the stress should be limited to 1 400 kgr./cm² (15 645 lb. per sq. in.) so as to cover future wear.

The calculation of the value of the coefficient of $G \cdot a$ in the formula for M is simplified by a diagram given in the paper. It is reproduced herewith (fig. 2)

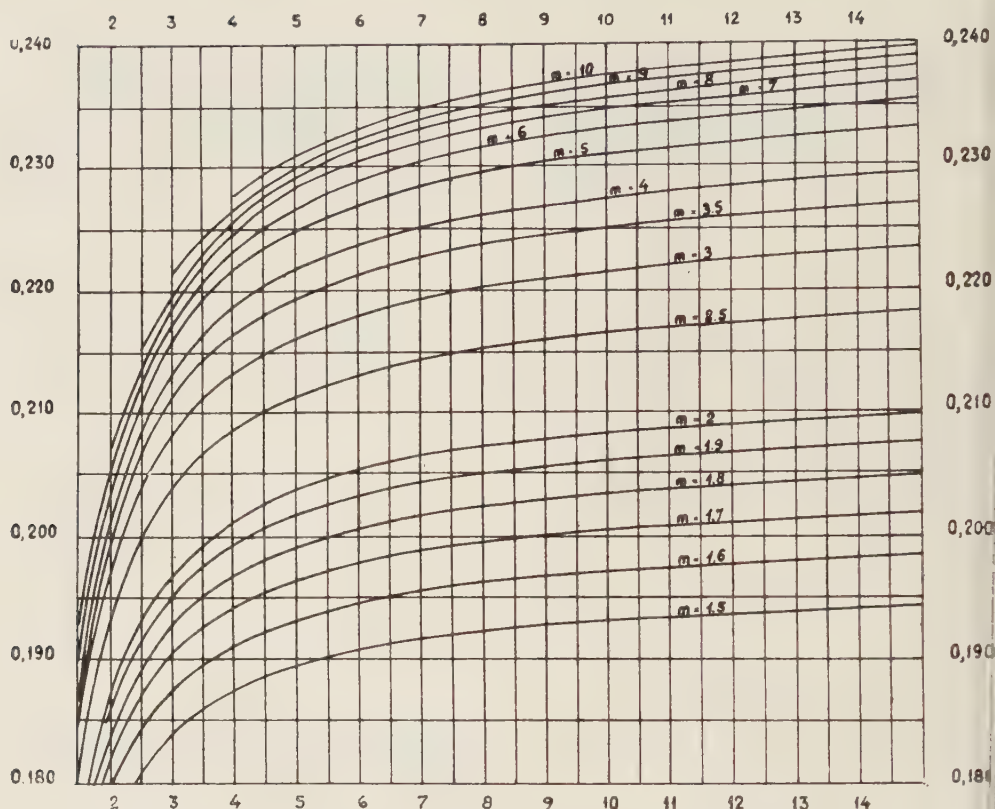


Fig. 2. — Chart showing the values of μ (ordinates) for different values of m and n (abscissæ) in the formula $M = \mu \cdot Ga$.

after extending it to include the smallest values of « n » most frequently met with in practice, and leaving out the part relative to the large values of « n », which are now rarely used.

The pressure transmitted by a sleeper should be calculated from the formula $\frac{G}{n}$, in which G is the mean load on the two pairs of wheels on each side of the sleep-

er and n , as before, the ratio of the distance between the centres of the wheels and that of the sleepers.

Recommended practice is to use 13 000 kgr. (12.8 Engl. tons) as the load transmitted by one sleeper in existing track, and 10 000 kgr. (9.84 Engl. tons) for proposed new lines when taking into account the increase factor due to the speed.

RECENT DEVELOPMENTS IN RAILWAY PRACTICE.

[625. 232 (.42)]

New « Flying Scotsman » trains, London and North Eastern Railway.

In 1888 — fifty years ago — the railway world was stirred to excitement by the last of the famous railway races to the north. It is singularly appropriate, therefore, that 1938 should see the introduction of two new trains for the « Flying Scotsman » which commenced running between King's Cross and Scotland in July.

These trains have been built at the Doncaster Works, to the designs of Sir Nigel GRESLEY, C. B. E., the Chief Mechanical Engineer, and in contrast with their famous predecessors, the « Silver Jubilee » and the « Coronation », they are not finished in special colours but

in the familiar varnished teak of the L. N. E. R. rolling stock.

The « Silver Jubilee » and « Coronation » trains are of the « limited » type in that the whole train runs between two points only, and all seats must be booked. The « Flying Scotsman » provides a different type of service, the train dividing at Edinburgh and serving Glasgow, Perth and Aberdeen. Such a service naturally influences the design of the trains with regard to both seating and restaurant car arrangements.

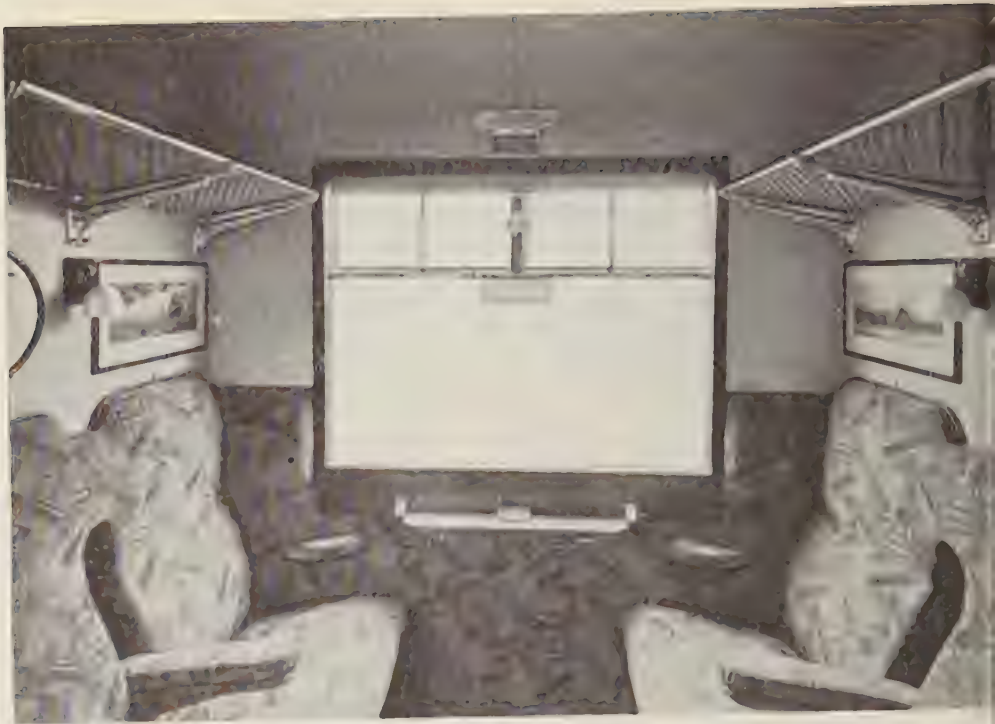
The new trains, which have been put into the 1938 Summer workings, are of the following formation :

Summer working.

	<i>Passengers</i>		
	<i>First</i>	<i>Third</i>	
Brake third	—	24	Aberdeen
Third class	—	42	»
Composite locker	12	21	»
Third class	—	42	Edinburgh
Buffet lounge	—	20	»
Third class	—	42	»
Third-class restaurant car.	—	42	»
Kitchen car	—	—	»
First-class restaurant car	36	—	»
First class	24	—	»
Third class	—	42	»
Luggage van.	—	—	»

Excluding the restaurant cars, the seating capacity is 36 firsts and 213 thirds.

The total weight of the train is 426 tons.



Third-class corridor compartment.



First-class restaurant car.



Buffet car



Third-class dining car.

For the Spring working two additional vehicles are included, the actual formation being as follows :

Spring working.

	<i>Passengers</i>		
	<i>First</i>	<i>Third</i>	
Brake third	—	24	Glasgow
Composite.	12	24	»
Composite locker	12	21	Perth
Third class	—	42	Edinburgh
Third class	—	42	»
Buffet lounge	—	20	»
Third class	—	42	»
Third-class restaurant car.	—	42	»
Kitchen car	—	—	»
First-class restaurant car	36	—	»
First class	24	—	»
Composite locker	12	21	Aberdeen
Third class	—	42	»
Luggage van.	—	—	»

The total seating capacity exclusive of restaurant cars is 60 firsts and 258 thirds.

The total weight of each train is 503 tons.

Thirteen vehicles only are used in the Winter working, the Glasgow, Perth and Aberdeen portions being formed as in the Spring working, and the leading third class carriage in the Edinburgh portion omitted.

The passenger accommodation throughout the train, with the exception of the buffet lounge and the restaurant cars, is arranged in corridor vehicles, and every effort has been made to ensure the maximum of comfort for the individual passenger.

The sound insulation which has been so successfully used in the « limited » trains has also been applied to the « Flying Scotsman ». Double glass is employed throughout, and acoustic blanket is used to insulate the sides and the roof. The floor insulation, in addition to compressed felt between the floorboards, comprises sprayed asbestos below the floor, supported on corrugated steel sheeting. Finally, the whole train

is fitted with the Stone's pressure ventilation apparatus.

Varying colour schemes have been employed throughout each train, the walls in all cases being covered with Rexine.

The first-class compartments each seat four passengers, the walls and ceiling being covered with peach coloured Rexine. The smoking compartments are upholstered in a blue and fawn uncut moquette with sponge rubber filling to the headrests and armrests and special spring fillings in the seats, while a silk covered cushion is provided for each passenger. Curtains of figured blue silk lined with silver satin are provided at each side window. The floor is covered with a blue Wilton rug, and the whole of the metal fittings are chromium plated. The compartments are exceptionally well lighted, a 30-watt sing light fitting being fixed in the ceiling and 30-watt reading lights at each passenger seat. Each compartment is fitted with special « no-fume » ash trays.

The non-smoking compartments are similarly arranged with regard to seat

and fittings, but red is the predominant colour, whilst flowered fawn uncut moquette is used as the seat covering.

A special feature of the first-class coach is the exceptional width of the corridor. The first-class corridors throughout the train are covered with blue carpet, with a sponge rubber underlay, and the vestibules with cocoa fibre mats. The whole of the corridors and vestibules are lined with flush panels of polished teak.

The scheme of decoration chosen for the third-class compartments has produced an air of spaciousness and light. The walls are covered in peach coloured rexine and the seats are upholstered in fawn and brown uncut moquette. The provision of special spring fillings has ensured an exceptionally comfortable seat.

The metal fittings are chromium plated, with the exception of the ceiling light which is of Alumilited aluminium. This fitting has a 30-watt lamp, and each compartment is also provided with four 15-watt shaded reading lamps above the seat backs.

A hair mat is also provided in each compartment.

The restaurant car set is the only articulated vehicle on the train and comprises first and third-class saloons with an electric kitchen between. The third-class saloon follows orthodox practice, the seating being arranged in separate smoking and non-smoking saloons.

The ceilings and upper portions of the saloon walls are covered with cream rexine, whilst the lower portions and floors are of rexine having a shagreen finish with a dividing band of red. The lido line, door architraves and ceiling fittings are of aluminium with Alumilite finish. The upholstery material is fawn and red uncut moquette.

The first-class saloon is a distinct departure from the usual standards and is a development of that in the « Corona-

tion » train. Each section of six seats is separated from the next by means of a light metal partition which is panelled in « Perspex », a transparent synthetic resin. This material is also used in the saloon intermediate doors.

The colour scheme is blue and silver relieved by the warmth of the carpet of bois-de-rose. The covering for the upper walls and ceiling is of pale blue rexine with rexine of a darker blue below the waist, the whole being framed and finished with Alumilited aluminium extrusions.

The rose coloured, silver lined curtains provide the necessary foil to the powder blue upholstery of the chairs, the plain antimaccassars of which are also outlined in rose coloured embroidery.

The luggage rack above each window is also of aluminium with Alumilite finish and incorporates a 30-watt lamp at each end, the provision of a 30-watt ceiling fitting completing the illumination of each section.

The electric kitchen equipment follows the practice successfully employed in all the latest L. N. E. R. trains, stainless steel being extensively used.

The range comprises a boiling top, one steaming and two roasting ovens, the vegetable boiler being a separate unit, placed conveniently adjacent to the sinks. Hot water for general purposes is provided from tanks in the corridor roof. A hot cupboard and coffee machine, together with a large electric refrigerator completes the kitchen equipment.

Separate pantries are provided for serving the first and third-class saloons.

The power for the cooking apparatus is obtained from two axle-driven dynamos, each of 10 kW. output, and a battery of traction type cells with a capacity of 210 ampere-hours.

A novel feature of the train is the provision of a buffet-lounge car in which light refreshments may be obtained.



First-class corridor compartment.

This vehicle is entirely independent of the restaurant cars and is intended for the convenience of passengers who do not require to avail themselves of the full restaurant-car service. The pantry equipment is all-electric and comprises a coffee machine, automatic toaster, ice cream cabinet and refrigerator.

The buffet saloon has been decorated to the designs of Messrs. Acton Surgey, and seats twenty passengers at small tables.

The scheme of interior decoration differs in each train.

In one scheme the walls are covered in silvered green Rexine, whilst the panels below the windows are of silver Rexine with a pink tinge. The ceiling is painted cream, whilst the stepped surrounds vary from pale green to the green of the Rexine. Mirror pilasters with etched ornamentation divide each passen-

ger section, whilst the whole of the cornices, window surrounds, arches, and ceiling ornaments are of Alumilited aluminium. Curtains of striped green, yellow and black with red braid are provided at the outer and corridor windows, and the floor is covered with brown cork tiling. The chairs are upholstered in green.

In the buffet car of the other train the predominant colour is rose with maroon upholstery on the chairs.

Adjoining the buffet is a ladies lounge and toilet room provided with settee, dressing tables and two washbowls.

The toilet compartments are similar throughout the train, the first class being decorated in green Rexine, and the third class in yellow. The coloured washbowls and sealed hoppers match the Rexine finish, whilst the hot and cold water supplies are obtained from

solenoid controlled valves operated by means of push buttons.

The whole of the train is supplied with fresh filtered air by means of electrically controlled pressure ventilation apparatus, which during cold weather automatically warms the air to a comfortable temperature. In summer time filtered air is delivered at atmospheric temperature.

The ventilator power unit is placed on the underframe and delivers the air at floor level by way of insulated ducts, the vitiated air being discharged through grilles into the roof duct connected to extractor ventilators.

For those who prefer direct ventilation, deep sliding ventilators with a lar-

ge opening are provided in each compartment and in the corridors.

The train is electrically lighted throughout each vehicle, with the exception of the kitchen car being fitted with its own axle driven dynamo and double battery which also provides power for the pressure ventilation unit.

The whole train is coupled by means of buckeye automatic couplers connected to india-rubber springs, and the gangways between the coaches are Pullman vestibules.

The coach bodies are built of teak and are mounted on steel underframes of welded construction, whilst compound bolster bogies ensure that the riding shall be of the high standard associated with the L. N. E. R.

NEW BOOKS AND PUBLICATIONS.

[625. 144.2 & 656. 2]

LAMALLE (U.), Ingénieur Civil des Mines, A. I. Lg., Assistant General Manager of the Belgian National Railways Company. — **Cours d'exploitation des chemins de fer.** Tome III: **Pose de la voie en courbe** (Railway Operating Course. Vol. III. — Track laying on curves, 2nd edition). — 1 vol. (10 × 8 inches) of 42 pages, with 42 figures. — 1938, Louvain, Librairie Universitaire Ch. Uystpruyst, Publisher.

As the reader will be aware, the laying of track on curves raises special problems, the additional factors involved being as follows :

1. The extra width or gauge widening;
2. The superelevation of the outside rail in order to obtain the cant necessary to counteract the effect of centrifugal force;
3. The transitions, usually parabolic, between the superelevated section of rail and the adjoining sections;
4. The use of shorter rail lengths on the inside in order to keep the joints opposite to each other.

These peculiarities of track laying on curves are dealt with clearly and systematically by Mr. LAMALLE in Volume III of his Course of Railway Operation as taught at the University of Louvain.

A special chapter is devoted to the tolerances allowed by the majority of

Railways in determining the superelevation.

Reduction of cant must be examined from the point of view of safety or stability of vehicles passing over the line, smooth running and comfort of passengers, and wear and tear of stock.

After discussing these aspects at length Mr. Lamalle concludes that a certain proportion of the centrifugal force may be left uncompensated for, and citing the German practice as an example, considers that the theoretical degree of cant as calculated for the maximum speed can be reduced without danger by 90 mm. (3 9/16 inches), a thesis admitted during the deliberations of the Railway Congress — 13th Session, Paris, 1937.

Finally, the author deals with the vertical transition curves necessary between the gradients of different slopes, in order to give a progressive change of slope without jar.

[385. (02 (.45)]

Reichsbahn-Handbuch, 1937 (*Manual of the German State Railways for the year 1937*) compiled by the Railway Department of the German Ministry of Communications. — A volume (8 × 6 inches) of 252 pages, with 2 coloured inset maps. — 1938, Leipzig; Published by the « Verkehrswissenschaftlichen Lehrmittelgesellschaft m. b. H. ». (Price, paper bound: 8.70 Rm.)

The aim of this publication, which was first issued in 1927, is to present a picture of the organic structure of the German State Railways; it replaces to some extent the handbook published at one time by the Prusso-Hessian Railways un-

der the title of « Service Information (Geschäftlichen Nachrichten).

Three editions followed the first : one in 1929, another in 1933, and, finally, in 1937, the one now under review. The successive editions have taken into ac-

count the alterations which have occurred in the international organisation and in the legal regulations governing the railway system. The work has become a valuable aid to the servants of the German Railways and must render great services to trading and industrial interests in facilitating their relations with the Railway.

The two opening chapters relate to organisation, the first dealing briefly with the duties of the ministerial departments responsible for all questions of communications and transport. The second gives a longer and exhaustive analysis of the whole of the German State Railway Administration.

The third chapter contains detailed statistical data regarding lines, rolling stock and other equipment, operating results and the trend of traffic.

Under the heading of « Miscellaneous » the fourth and last chapter gives, *inter alia*, a short review of the rates and fares in operation.

The handbook includes a separate map, in colours, drawn to a scale of 1 in 1 500 000, shewing all the railway lines in the country, divided into *Regional Managements*; also the motor ways now open, under construction or projected.

E. M.

[624 (.43)]

Geh. Baurat Dr.-Ing. chr., Dr. tech. h. c. G. SCHAPER, Reichsbahndirektor. — **Neue deutsche Forschungsarbeiten und Ausführungen auf dem Gebiete des Stahlbrückenbaues** (*New German research and practice in steel bridge construction*). — A pamphlet (6 3/4 × 9 3/4 inches), of 60 pages, profusely illustrated. Abstracted from the review « *Der Bauingenieur* », *Zeitschrift für das gesamte Bauwesen*, 1937, No. 37/38.

Under the above title, Dr. SCHAPER, following the general outline of a lecture given by him in England, in 1937, surveys the progress in bridge construction, made in Germany during recent years.

Generally speaking, the German Engineers have endeavoured to improve the qualities of the steels used, and have had recourse to new methods of conception and execution, making it possible to give the structures some claim to architectural beauty.

The progressive increase in loads due to heavier locomotives and rolling stock, and the desire for economical structures of graceful aspect, have led the German steel producers to evolve a steel known as « St. 52 », which may be said to have a safety factor 50 per cent. higher than that of the « St. 37 » commercial steel in ordinary use.

The « St. 52 » steel has proved to be particularly suitable in the case of road bridges where the proportion of stresses

due to dead weight is high as compared to those due to live loads and also, for similar reasons, in the case of railway bridges of long span.

For railway bridges of short span, where the stresses due to moving loads predominate, « St. 37 » steel retains certain advantages.

The use of « St. 52 » steel instead of the « St. 37 » grade for large structures makes possible a saving in cost of up to 15 per cent.

Dr. SCHAPER then describes at some length the application of welding to the metal framework of bridges.

In 1930, after exhaustive researches, the German State Railways put into service an experimental railway bridge of 10 metres (32.8 ft.) span with main girders of solid web type.

This bridge has now given satisfaction in service for more than 6 years, during which time about 230 000 trains have

passed over it, and a thorough examination at the Berlin-Dahlem materials testing laboratory has not revealed any defects, although some of the welds were carried out in 1930 by methods now abandoned.

All the welded bridges which have so far been constructed, both road and railway, are of the type with main girders with solid web.

The German Engineers are not yet entirely satisfied as to the behaviour of joints in trellis girders.

Dr. SCHAPER then summarises the advantages of welding, chief of which is

the great reduction in weight as compared with rivetted bridges, and states that, for equal spans and loads, the saving may amount to as much as 23 per cent.

Particular stress is laid on the simplicity of the structures and their sober and vigorous appearance.

The work abounds in photographs and descriptions of multiple-span structures, some of which were built when the motor ways were constructed and fall into perfect harmony with the surrounding country.

J. D.

[621. 45 (02 (.45)]

Elsners Taschenbuch für den Reichsbahn-Kraftverkehr (*Elsner's Handbook for the road and rail motor traffic of the German State Railways*), 1938 (Third year). — One volume (6 1/4 × 4 3/8 inches) of 442 pages with many figures. — 1938, Berlin, Otto Elsner Verlagsgesellschaft. (Price : 3 Rm.)

In the June 1938 issue of the *Bulletin*, we reviewed the Elsner Locomotive and Rolling Stock Repair Shops Handbook. For the last three years the same firm has published a similar book covering petrol or diesel-engined stock, i. e. the German State Railways road motor cars and lorries, small shunting engines, railcars, etc...

The 1938 handbook can be subdivided into two main parts : one dealing with road motor vehicles, and the other with railcars. After a brief introduction describing the state of the motor industry in Germany in 1938, the book describes new types of motors and motor lorries put into service on the State Railways in 1937. Important chapters are devoted to the theory and description of the parts of petrol and diesel engines for motor vehicles, to the fuels and lubricants used, to descriptions of the brake gear and tests thereof, and to the question of

pneumatic tyres : their failures, fitting them and repairing them. The book also includes the regulations on the maintenance and repair of motor vehicles on the State Railways, as well as the new official traffic regulations and those on road signalling.

The second part completes the report on the evolution of the railcar on the German State Railways, as given in the 1937 issue, by describing the new types of railcars put into service in 1937. The most important chapter is that devoted to a very complete study of the transmissions now in use : mechanical, electrical and hydraulic. The book ends with a short memento of general information.

To all railway engineers interested in the subject, this handbook drawn up in collaboration with the specialists of the State Railways will prove a mine of information about the German practice as regards road motor vehicles and railcars.

A. C.

[621. 131]

GREGORIO (Dott. Ing. Camillo de). — **L'elevamento di pressione nelle locomotive ed i focolari** (*Increased locomotive boiler pressures. Locomotive fireboxes*). — A pamphlet 8 1/2 × 12 1/2 inches) of 6 pages, with 7 graphs. — Abstracted from *L'Energia Termica*, 3rd March, 1938, number. — 1938, Milan, Presniata Tipografia Agraria di G. Castiglioni, 7, via Stoppani.

The paper by Dr. C. DE GREGORIO forms an interesting contribution to the problem of improving the steam locomotive of conventional type in order to increase its power. It commences with a thermodynamic study of boiler pressure increase, based on the efficiency curves of the ideal cycle and of the Rankin cycle, also the curve giving the ratio between these two cycles in relation to boiler-pressure. Next is examined the variation in the production of steam per square metre of heating surface, also the variations in the power developed by the locomotive and in boiler efficiency, in relation to rate of combustion. The specific maximum production of steam is,

moreover, influenced by the firebox volume in relation to the grate area, owing to the more or less perfect combustion; in this connection the results of tests made at Altoona by the Pennsylvania Railroad are shown by a graph.

The author then passes on to an examination of the question of draught, and studies the relations between the rate of combustion, speed and power developed for locomotives of various types. The paper terminates with the question of using pulverised coal and liquid fuels in an ordinary firebox, by comparison, as regards liquid fuels, with their use in a diesel locomotive.

A. C.

[662]

La technique des industries du pétrole [*The Technique of the Oil Industry*]. (*Science et Industrie*, Monthly Review; special issue)]. One volume (10 × 12 1/2 inches), 192 pages, profusely illustrated. — 1938, Paris, 29, rue de Berri.

In the October, 1937, number of the *Bulletin*, we announced the issue of a special supplement to the Review *Science et Industrie*, dealing with the oil industry and forming in some sort a preface to the 2nd World Oil Congress (Paris, 1937).

Science et Industrie has just issued a further supplement giving details of recent progress in the industry, which is characterised by great vitality and by rapid and continuous development.

The supplement opens with a survey of the conclusions arrived at by the Paris Congress, these being given by persons of note in the various sections of the Congress. This is followed by detailed explications of the more important questions

on the agenda, among which the most outstanding is the obtaining of motor spirits having a high octane index. Extensive chapters are devoted to recent progress and present trends in the oil industry in the United States, the uses of butane and propane, the oil supply in France and the development of sources of supply, the position of the refining industry in France; a description of modern equipment for the manufacture of motor fuels and questions of liquid fuel storage.

This monograph constitutes, as will be seen, a new and valuable addition to the existing sources of information on the technique of this important branch of industry.

A. C.

ERRATUM.

Bulletin, August 1938, pages 840 and 841. Article by E. Monier on « Welded cylinders for 2-8-2 locomotives, French National Railways Company ».

Figures 12, 13 and 14 should be arranged as follows :

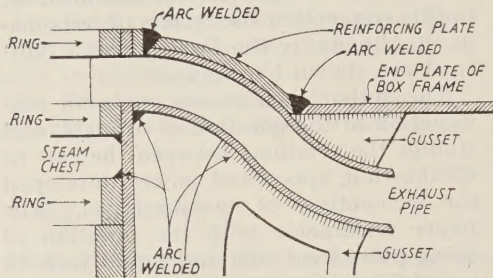


Fig. 12. — Reinforced and gusseted connection between end of cylinder boxing and steam-chest.

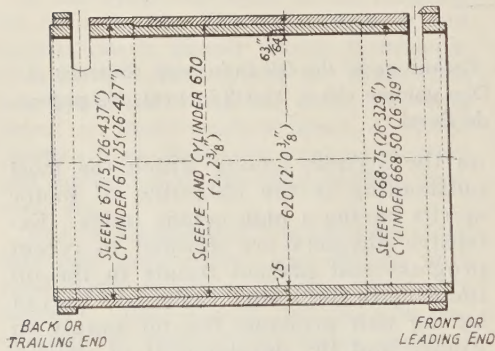


Fig. 13. — Details of cylinder liner.

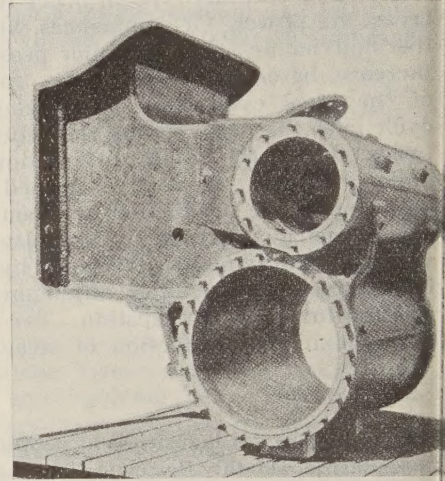


Fig. 14. — Completed cylinder and steam chest, studded and tested hydraulical.